90709

TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, [redacted] 1919

No. [redacted]63

FRANK A. BONE, PETITIONER,

vs.

COMMISSIONERS OF MARION COUNTY.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT.

PETITION FOR CERTIORARI FILED FEBRUARY 25, 1919.
CERTIORARI AND RETURN FILED MARCH 30, 1919.

(26,352)

TRANSCRIPT OF RECORD.

IN THE SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1913.

No. 371.

PEAVEY & BOYD, PETITIONERS,

vs.

COMMISSIONERS OF MARION COUNTY.

ON WRIT OF CERTIORARI TO THE SUPREME COURT OF THE STATE OF [illegible]
OF APPEALS FOR THE SEVENTH CIRCUIT.

PETITION FOR CERTIORARI FILED FEBRUARY 13, 1913.
CERTIORARI AND RETURN FILED MARCH 29, 1913.

(28,382)

(26,352)

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1918.

No. 371.

FRANK A. BONE, PETITIONER,

vs.

COMMISSIONERS OF MARION COUNTY.

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT.

INDEX.

JUDD & DETWEILER (INC.), PRINTERS, WASHINGTON, D. C., AUGUST 27, 1918.

a In the United States Circuit Court of Appeals for the Seventh Circuit, October Term, A. D. 1916.

No. 2459.

FRANK A. BONE, Appellant,

vs.

COMMISSIONERS OF MARION COUNTY, Appellee.

Appeal from the District Court of the United States for the District of Indiana.

Mr. Arthur H. Ewald, Mr. Oliver W. Sharman, Mr. Clarence E. Mehlhope, Counsel for Appellant.
Mr. V. H. Lockwood, Counsel for Appellee.

1 *Bill of Complaint. Filed June 12, 1912.*

In the District Court of the United States for the District of Indiana, May Term, 1912, June 12th, 1912.

In Equity.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Before the Honorable Albert B. Anderson, Judge.

Comes now the complainant by George B. Parkinson, Esq., his solicitor, and files a Bill of Complaint in the above entitled cause in the words following, to-wit:

To the Honorable the Judges of the District Court of the United States in and for the District of Indiana:

Frank A. Bone, residing at Cincinnati in the State of Ohio, and citizen of said state, brings this his bill against the commissioners of Marion County, a municipal corporation duly organized under the laws of the state of Indiana, citizen of said state, inhabitant of said District of Indiana, and having its principal place of business at Indianapolis in said county and state.

And thereupon your Orator complains and says that heretofore

and before the 21st day of April, 1899, he was the true, original and first inventor of a certain new and useful improvement in Retaining Walls not known or used in this country and not at the time of his hereinafter recited application for a patent therefor, in public use or on sale for more than two years, not patented or described in any printed publication in this or any foreign country before his said invention or discovery thereof, and not patented by him, or with his consent or allowance, in any foreign country upon an application filed more than twelve months prior to his hereinafter recited application for a patent therefor.

And your Orator further shows unto your Honors, that he being, as aforesaid, the inventor of said improvement, and being a citizen of the United States, made application to the Commissioner of Patents for Letters Patent, in accordance with the then existing Acts of Congress, and having duly complied in all respects with the conditions and requisitions of said Acts, on the twenty ninth day of July, 1902, Letters Patent of the United States, signed, sealed
2 and executed in due form of law, for the said invention or discovery, were issued to him and numbered 705,732, whereby there was secured to him, his heirs, executors, administrators or assigns for the term of seventeen years from the twenty ninth day of July, 1902, the full and exclusive right of making, using and vending to others to be used, the said improvement which said Letters patent are now of record in the Patent Office of the United States, and a certified copy of which is ready here in court to be produced.

And your Orator further shows *until* your Honors, that by virtue of the premises, he became, and now is the sole and exclusive owner of said Letters Patent, and the invention and improvements described therein, and of all the rights and privileges granted and secured, or intended to be granted and secured thereby. And that since he became the owner thereof, as aforesaid, he has invested and expended large sums of money and been to great trouble in and about said invention, and for the purpose of carrying on the business of installing said retaining walls and making the same profitable to himself and useful to the public; and that said invention has been and is of great benefit and advantage; and that many retaining walls were made according to said invention and sold by your Orator to great advantage to the public; and that the public have generally acknowledged and acquiesced in the aforesaid rights of your Orator; and your Orator believes that he will realize and receive large gains and profits therefrom if infringements by said defendant and its confederates shall be prevented.

Yet the said defendant, well knowing the premises and the rights secured to your Orator, as aforesaid, but contriving to injure your Orator and to deprive him of the benefits and advantages which might and otherwise would accrue unto him from said invention, after the issuing of the Letters Patent, as aforesaid, and before the commencement of this suit, did, as your Orater — informed and believes, without the license or allowance, and against the will of your Orator, and in violation of his rights and in infringement of the

aforesaid Letters patent, within the District of Indiana, unlawfully and wrongfully, and in defiance of the rights of your Orator, make, construct and use the said invention, and did make, construct and use Retaining Walls made according to, and employing and containing said invention, and that it still continues to use said walls.

All in defiance of the rights acquired by and secured to
3 your Orator as aforesaid, and to his great and irreparable loss and injury, and by which he has been and still is being deprived of great gains and profits which he might and otherwise would have obtained, and which have been received and enjoyed, and are being received and enjoyed, by the said defendant by and through its aforesaid unlawful acts and doings.

And your Orator further shows unto your Honors, on information and belief, that said defendant has made and realized large profits and advantages from its installation and use of said patented retaining walls; but to what extent, and how much exactly, your Orator does not know, and prays a discovery thereof. And your Orator says that the use of the said invention by said defendant and its preparation for and avowed determination to continue the same, and its other aforesaid unlawful acts, in disregard and defiance of the rights of your Orator have the effect to and do encourage and induce others to venture to infringe said patent, in disregard of your Orator's rights.

And your Orator further shows unto your Honors, that he has caused notice to be given to said defendant of said infringements, and of the rights of your Orator in the premises, and requested it to desist and refrain therefrom; but it has disregarded said notice, and refused to desist from said infringements, and still continues to make and use said retaining walls.

And forasmuch as your Orator can have no adequate relief except in this court, to the end that defendant may be compelled to account for and pay over the income thus unlawfully derived from the violation of the rights of your Orator as above, and be restrained from any further violation of said rights, your Orator prays that your Honors may grant a writ of injunction, restraining the defendant from any further construction, or sale, or use in any manner of said patented retaining walls or any part thereof, in violation of the rights of your Orator as aforesaid and that the walls now in possession or use of the said defendant may be destroyed. And also, that your Honors, upon the entering of a decree for infringement, as above prayed for, may proceed to assess, or cause to be assessed under your direction, in addition to the profits to be accounted for by defendant as aforesaid, the damages your Orator has sustained by reason of such infringement, and that your Honors may increase the actual damages so assessed, to a sum equal to three
times the amount of such assessment, under the circum-
4 stances of the wilful and unjust infringement by said defendant, as herein set forth. And your Orator prays also for a provisional or preliminary injunction, and for such other relief as the equity of the case may require, and as to your Honors may seem meet.

May it please your Honors to grant unto your Orator a writ of injunction conformable to the prayer of this bill, and also a writ of subpœna of the United States of America, directed to the said Commissioners of Marion County commanding said County to appear by its Commissioners and answer unto this bill of complaint, not however under oath, answer under oath being expressly waived, and to abide and perform such order and decree in the premises as to the court shall seem meet, and be required by the principles of equity and good conscience.

FRANK A. BONE.

GEORGE B. PARKINSON,
Solicitor for Plaintiff.

THE UNITED STATES OF AMERICA, *ss:*

On this 1st day of June, 1912, before me personally appeared Frank A. Bone, the above named plaintiff, who made solemn oath that he had read the foregoing bill of complaint, subscribed by him, and knows the contents thereof, and that the same is true of his own knowledge except as to the matter therein stated on information and belief, and as to those matters he believes it to be true.

[SEAL.] SULTAN KLEIN,
Notary Public in and for the County of Hamilton and State of Ohio.

5 *Amended Answer.*

Filed Feb. 24, 1913.

In the District Court of the United States for the District of Indiana, November Term, 1912, February 24th, 1913.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Before the Honorable Albert B. Anderson, Judge.

Comes now the defendant by V. H. Lockwood, Esq., and Messrs. Brown & Brown their solicitors and by leave of Court, file an amended answer herein in the words and figures following to wit:

Amended Answer.

The answer of the Commissioners of Marion County, defendant in the above entitled cause, to the bill of complaint of Frank A. Bone, complainant:

These defendants, now and at all times hereafter saving and reserving to themselves all manner of benefit or advantage of exception which can or may be had or taken to the many errors, insufficiences and inaccuracies in said bill of complaint contained, for answer thereto or unto so much thereof as they are advised that it is material for them to answer, say:

1. These defendant- deny, upon information and belief, that the said complainant was on or before the 21st day of April, 1899, the true, original and first inventor of a certain new and useful improvement in Retaining Walls, described and claimed in the letters patent set forth in said bill of complaint; and they deny that said invention was not known or used by others in this country, or patented and described in any printed publication in any count-y, prior to his alleged invention thereof or for more than two years prior to his application for letters patent as set forth in said bill of complaint; and they deny that said alleged invention had not been in public use or on sale in this country for more than two years prior to the application for said letters patent or had not been patented or caused to be patented in any foreign country, with his consent or
6 allowance, upon an application filed more than 12 months prior to the alleged application for letters patent in this country; and as to all allegations in the bill of complaint with reference to the foregoing matters the defendants require strict proof by the complainant.

2. These defendants, upon information and belief, deny that the said complainant made application to the Commissioner of Patents according to law for the alleged letters patent No. 705,732, mentioned in said bill of complaint, or that he became the sole and exclusive owner of said alleged invention and letters patent therefor, or that he complied in all respects with the requirements of law in the prosecution of said application, or that the alleged letters patent No. 705,732, were lawfully issued and delivered unto said complainant, or that said complainant secured thereby for the term of seventeen years the exclusive right to make, use and vend said alleged invention throughout the United States; but said defendants insist that strict proof of all the allegations of the bill of complaint with reference to the foregoing matters shall be mad- by the complain-t.

3. These defendants deny, upon information and belief, that the said complainant has invested and expended large sums of money and been to great trouble in and about said invention and in installing said retaining walls, or that said invention has been and is of great benefit and advantage to the complainant, or that many retaining walls have been made by the complainant according to said invention, or that the public have generally acknowledged and acquiesced in the aforesaid rights of the complainant, or that the complainant will realize and receive large profits therefrom.

4. These defendants deny that they ever had any knowledge of the premises and the rights alleged to have been secured to the said complainant as set forth in said bill of complaint, or that they ever had any notice whatsoever from the said complainant or from any

other person, firm or corporation relative to said letters patent, or any claims of the complainant as to any rights thereunder; or that they, or any of them, ever contrived to injure the complainant or deprive him of the benefits and advantages which might and otherwise would have accrued to him from said alleged invention, or that they or any of them, have ever infringed any right whatsoever of the said complainant in or under said letters patent, No. 705,732, within the said District of Indiana; or that they, or any of them, have ever unlawfully and wrongfully and in defiance of the rights of the
7 complainant made or constructed or used any invention claimed in said letters patent; or that they, or any of them, ever made, constructed or used any retaining walls made according to and containing the invention claimed in said letters patent, or that they, or any of them, have at any time threatened or proposed in any manner to make, construct or use any retaining walls or other structure covered by any claim in said letters patent, or that any great or irreparable loss or injury has accrued or will accrue to said complainant by any action of the said defendants, or any of them, or that said complainant has been or is being deprived of any gains or profits to which he is lawfully entitled by reason of any act or any manufacture, sale or use of any invention covered by said letters patent.

5. These defendants further deny, upon information and belief, that said complainant has marked the retaining walls, or other structures built by or under the authority of said complainant with the word "Patented," together with the date of said letters patent No. 705,732.

6. These defendants allege that the said alleged invention set forth in said letters patent does not rise to the dignity of invention, but amounted to nothing more than the exercise of the skill of the ordinary workman in the art to which the invention relates; and that the alleged combinations claimed in said letters patent are not patentable combinations but mere aggregations brought together by the choice of the workman from the well known prior art.

7. These defendants deny that the alleged invention set forth in said letters patent No. 705,732 mentioned in the said bill of complaint, was new in any patentable sense at the time of the said alleged invention thereof by the said complainant, and that retaining walls and like structures substantially identical with that shown and claimed in said letters patent were shown, described and published in letters patent granted by the United States and foreign countries for retaining wall and like structures to the parties and on the dates and with the numbers set forth below, and other publications set forth below, and prior to the alleged invention of the said complainant, or more than two years prior to the alleged application for letters patent by the said complainant, and said invention was originated and invented by the patentees set forth in said letters patent prior to the time of the said alleged invention of the said complainant, to-wit:

8 U. S. Letters Patent.

No. 165,371, dated July 6, 1875, to William Schmolz, for Construction of Dams.

No. 206,112, dated July 16, 1878, to Thaddeus Hyatt, for Composition Floors, etc.

No. 302,664, dated July 29, 1884, to Joseph Monier, for Construction of Railway Sleepers, etc.

No. 314,941, dated March 31, 1885, to Frank A. Hyatt, for a Jetty.

No. 317,338, dated May 5, 1885, to John C. Goodridge, Jr., for Process of Construction and Repair with Beton or Concrete.

No. 371,843, dated Oct. 18, 1887, to Peter H. Jackson, for Building and Bridge Construction.

No. 411,360, dated Sept. 17, 1889, to Omar A. Stempel, for Post, etc.

No. 462,437, dated Nov. 3, 1891, to Peter H. Jackson, for Construction of Floors or Walls.

No. 462,953, dated Nov. 10, 1891, to Peter H. Jackson, for Dampproof and Watertight Cellar.

No. 474,988, dated May 17, 1892, to John D. Derry, for Dam, Wier or Retaining Wall.

No. 489,792, dated Jan. 10, 1893, to Jas. E. Chapman, for Border for Walks, etc.

No. 504,924, dated Sept. 12, 1893, to Peter H. Jackson, for Metallic Tie, etc.

No. 508,308, dated Nov. 7, 1893, to Franklin Haines, for Street Curbing.

No. 571,225, dated Nov. 10, 1896, to Adam Geisel, for Concrete Bridge.

No. 583,464 dated June 1, 1897, to Friedrich von Emperger, for Vault for Ceilings, Bridges, etc.

No. 590,690, dated Sept. 28, 1897, to Joseph S. Small, for Framework for Concrete-Iron Construction.

No. 591,949, dated Oct. 19, 1897, to George M. Cheney, for Arch Culvert.

No. 592,738, dated Oct. 26, 1897, to William V. Judson, for Retaining Wall.

No. 597,281, dated Jan. 11, 1898, to Adam Geisel, for Concrete Bridge.

No. 606,696, dated July 5, 1898, to Guy B. Waite, for Beam Construction for Buildings.

No. 607,223, dated July 12, 1898, to Alphonse De Man, for Artificial Slab.

9 No. 611,907, dated Oct. 4, 1898, to Francois Hennebique, for Construction of Joists, Girders and the Like.

No. 617,615, dated Jan. 10, 1899, to E. Thacher, for Concrete Arch.

No. 623,714, dated April 25, 1899, to Bror O. V. Hellstrom, for Post and Bar Applicable for Telephone or Telegraph Poles, etc.

No. 623,904, dated April 25, 1899, to Howard V. Hinckley, for Construction of Metal Concrete Arch Bridges.

No. 629,477, dated July 25, 1899, to Charles F. Stowell and Andrew C. Cunningham, for Walls.

No. 630,457, dated Aug. 8, 1899, to Alexander Hogeland, for Ship Canal, etc.

No. 643,488, dated Feb. 13, 1900, to John S. Fielding, for Dam, Retaining Wall, etc.

No. 654,683, dated July 31, 1900, to Ira A. Shaler, for Concrete Construction.

No. 672,475, dated April 16, 1901, to Frederick Melber, for Cement or Concrete Construction.

Letters Patent of Great Britain.

No. 1,741, dated Jan. 28, 1892, to Matthias Koenen and Gustav A. Wayss.

No. 2,128, dated June 18, 1874, to Phillip Brannon.

No. 2,703, of 1871 to Brannon.

No. 3,571, dated Nov. 24, 1868, to Thomas Prideaux.

No. 4,048, dated Feb. 25, 1895, to Gustav Von Breymann-Schwertenberg.

No. 4,335, dated Oct. 5, 1881, to Walter R. Kinnipple.

No. 5,228, dated Nov. 30, 1881, to John Thomas.

No. 8,814, dated May 12, 1900, to Hennebique.

No. 11,021, dated Aug. 7, 1884, to Albert Hubner.

Letters Patent of France.

No. 228,147, granted Feb. 22, 1893, to A. M. Rau, for "Un procede pour la construction de parois, piliers ou constructions semblables en charpente en fer et beton pise."

Other Publications.

In the book entitled "Tijdschrift van het Koninklijk Institunt Van Ingenieurs," published on or about February 1, 1894, at Te'S-Gravenhage, Halland, by Gerbs, J. A. H. Van Langenhuysen, special reference being made to the printed report therein of the proceedings of said institunt on November 14, 1893, and to the article published therein of R. P. J. Tutein Nolthenius on Monier concrete constructions, and discussions thereon, to be found on pages 39 to 53 and plates II and III of said book.

In the book entitled "Concrete Constructions," by F. Rehbein, Royal Architect of Germany, published in 1894, at Berlin, Germany.

In the book entitled "Annals de Travaux Publics de Belgique," published in 1898 at Bruxelles, Belgium by J. Goemaers, special

reference being made to Volume 55, pages 841 to 842 and Plate XXXIII, and to the article thereon entitled Revetment de talus en beton arme.

In the book entitled "Carpentry Made Easy," by William E. Bell, published in 1857, at Philadelphia, Pennsylvania.

In the book entitled "Le Genie Civil," published at Paris, France, on February 11, 1899, Volume on Tome XXXIV, Plate XV. (Fig. 3.)

In Cement and Engineering News, Volume 1, No. 4, pages 56 to 58 and 70-73, published at Chicago, Illinois, on October, 1897.

In Cement and Engineering News Volume III, No. 3, pages 39-41, published at Chicago, Illinois, in September, 1897, and Volume 1, No. 5, pages 72-73, published at said Chicago, November, 1896.

In the book entitled "Le Genie Civil," Nov. 12, 1898 (No. 857) pages 22-24; of Nov. 26, 1898 (No. 859) pages 57-58; of Dec. 3, 1898 (No. 860) pages 86-88; of Dec. 17, 1898 (No. 862) pages 103-105, all published at Paris, France, on the dates mentioned.

In the book entitled "The Monier System," (Iron and Steel with Concrete Filling) in its Application to Building, by A. Seydel & Co., published 1887 at Berlin, Germany.

In the book entitled "The Engineer," Vol. 79, pages 395-399, published at London, England, May 10, 1895.

In the book entitled Le Ciment, published at Paris, France, in 1896, Vol. 1, dated Sept. 25, 1896, pages 105-110.

In the book entitled "Rudimentary Treatise on Foundations and Concrete Works," *by* E. Dobson, published at London, England, 1850, pages 1 to 25.

In Chambers Encyclopedia, Volume VIII, pages 216, 217, under title "Retaining Walls," published in 1884 at Philadelphia, Pennsylvania, by J. B. Lippincott & Co.

11 In "Engineering News" published at New York City, New York, February 16, 1893, Volume XXIX, No. 7, page 148.

In "Engineering News" published at New York City, New York, May 23, 1891, Volume XXV, No. 21, pages 499, 500.

Annalles des Ponts et Chausees, Sixth Series, Volume 18, Second Half, Published in Paris, 1889, with particular reference to pp. 49 to 128.

Notice sur les Constructions en ciment Arme, by J. de Bois, published in 1898, at Paris by Vve. Ch. Dunod, Editeur, 49 Quai Des Grands Augustins, with particular reference to page 17, though all the book, which is small, has more or less pertinency.

Le Genie Civil, Vol. 28, published at Paris on the 12th of December, 1895, with particular reference to page 123.

Le Genie Civil, Volume 34, No. 3, November 19, 1898, pages 40 and following, published at Paris in 1898, and in other publications at present to these defendants unknown, but which they pray leave to insert whenever discovered.

8. These defendants further say, upon information and belief, that the retaining walls and like constructions containing the improvements in all substantial and patentable respects similar to the alleged

improvements claimed in said letters patent No. 705,732, were known to and publicly made, sold and used in the United States by many persons prior to the said alleged invention of the said complainant, and more than two years prior to the date of his application for said letters patent, particularly by the following persons and at the following places, to-wit:

John S. Fielding, of Pittsburgh, Pennsylvania, at Pittsburgh, Pennsylvania, and elsewhere;

Frederick Melber, of Pittsburgh, Pennsylvania, at Pittsburgh, Pennsylvania, and elsewhere;

Peter H. Jackson, of San Francisco, California, at said San Francisco, California, and elsewhere.

Ira A. Shaler, of New York City, New York, at New York City, New York, and elsewhere;

Charles F. Stowell, of Albany, New York, at Albany, New York, and elsewhere;

Andrew C. Cunningham, of Albany, New York, at Albany, New York, and elsewhere;

Thaddeus Hyatt, of New York City, New York, at New York City, New York, and elsewhere;

12 Edwin Thacher, of New York City, New York, at New York City, New York, and Detroit, Michigan, and elsewhere;

Alexander Hogeland, of Louisville, Kentucky, at Louisville, Kentucky, and elsewhere;

Ernest L. Ransome, of New York City, New York, at New York City, New York, at Oakland, California, at San Francisco, California, and elsewhere;

Ransome & Smith Co. of Chicago, Illinois, at Chicago, Illinois, and elsewhere;

Ransome & Smith Co. of San Francisco, California, at San Francisco, California, and elsewhere;

Illinois Steel Company, of Chicago, Illinois, at Chicago, Illinois, and elsewhere;

William Muesser, of New York City, New York, at New York City, New York, and elsewhere;

Melan Arch Construction Co. of New York City, New York, at New York City, New York, and elsewhere.

9. These defendants further say, upon information and belief, that the alleged invention set forth and claimed in the said letters patent No. 705,732, was actually abandoned by the said complainant, prior to his alleged application for letters patent therefor.

10. These defendants further say that the said complainant was not the original and first inventor and discoverer of a material and substantial part of the device set forth and claimed in said letters patent, No. 705,732; and that the said complainant has never filed in the United States Patent Office any disclaimer thereof to the great injury of these defendants and the public generally.

11. These defendants further allege that they, prior to the bringing of this suit, never had any knowledge of the patents in suit, or the claims thereof, or that the said invention was covered by the

patent in suit, and that if said invention, or any feature thereof, as covered by said patent in suit, has been at any time introduced into any bridge or bridges erected in Marion County, Indiana, the same was without the knowledge, consent or authority of these defendants and in direct violation of any authority granted by these defendants to any person, firm or corporation to erect bridges in said County; that these defendants never personally built any bridge in Marion County, Indiana, and if any person, firm or corporation has erected any bridge in Marion County containing said alleged invention set forth and claimed in said letters patent, it has been done at
13 the instance and upon the motion of some person other than these defendants and without their knowledge and authority, and that so far as these defendants now have knowledge and are informed, there never has been any such bridge erected in Marion County.

12. These defendants further allege that if there be any bridge located in the County of Marion, State of Indiana, containing any improvement covered by any claim in the patent in suit, the same has been erected and constructed with the knowledge of the complainant herein, or those acting for and in his behalf, and without complaint or objection by him, at or before any such bridge was constructed, or at any time thereafter prior to the bringing of this suit, and, therefore, the public has acquired a right to use said bridge both heretofore and hereafter without destruction of said bridge or interference with the use of the same by the public at the instance of said complainant.

13. These defendants further allege that if there be any bridge in Marion County, State of Indiana, which contains any invention covered by the letters patent in suit, such bridge is in constant daily use by the public, and any destruction thereof would seriously interfere with the business and transportation and travel of the public, and that the destruction of such bridge would work an unnecessary and very serious injury to the public, and that the travel, transportation and business of the public should not be interfered with by the destruction of the bridge in pursuance of the prayer of complainant.

14. These defendants further allege that the said complainant in his bill of complaint has failed to specify any particular bridge or bridges located in said County of Marion, State of Indiana, in which he claims that any improvement covered by said letters patent is to be found, and there is a large number of bridges erected in Marion County, and these defendants are unable to know which bridge or bridges the said complainant claims to be in infringement of the patent in suit, or to notify the builders or contractors of any such bridge or bridges of the pertinency of this suit, whereby said contractors and builders could protect themselves against the claims and prayers of the complainant in his said bill of complaint.

All of which statements and defenses these defendants are ready to aver, maintain and prove as this Honorable Court shall

14 direct, and pray hence to be dismissed with their costs most wrongfully sustained.

COMMISSIONERS OF MARION COUNTY.

BROWN & BROWN,
Solicitors for Defendants.
V. H. LOCKWOOD,
Counsel for Defendants.

In the United States District Court for the District of Indiana.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Motion.

Comes now the defendants, by their solicitors, and move the Court to permit them to file an amended answer in the above-entitled cause, as set forth in the copy thereof attached hereto.

V. H. LOCKWOOD,
Solicitor for Defendants.

Messrs. Hooten & Hack, Solicitors for Complainant.

GENTLEMEN: Please take notice that the foregoing motion to file an amended answer will be presented to His Honor, Judge A. B. Anderson, on Thursday, February 20, 1913, at 9:30 o'clock in the forenoon, or at such time thereafter as the matter may be reached by the Court.

V. H. LOCKWOOD,
Solicitors for Defendants.

15 In the United States District Court for the District of Indiana.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Affidavit of Service.

STATE OF INDIANA,
County of Marion, ss:

Gertrude H. Boink, being first duly sworn, deposes and says that on February 12, 1913, she deposited in the post office at Indianapolis, Indiana, an envelope, which was sealed and stamped and which

contained a true and correct copy of the Answer and Motion attached hereto; that said envelope was registered as shown by the registry return receipt hereto attached; and that the same was addressed as follows:

Messrs. Hooten & Hack, 525 Indiana Trust Bldg., Indianapolis, Ind.

GERTRUDE H. BOINK.

Subscribed and sworn to before me, a Notary Public, this 17th day of February, 1913.

JULIA H. WELLS,
Notary Public.

[SEAL.]

Commission expires April 16, 1916.

(Registry return receipt attached.)

In the United States District Court for the District of Indiana.

In Equity.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Stipulation.

It is hereby stipulated that the answer in the above entitled cause may be amended by substituting the attached sheets Nos. 7, 8, 9 and 9½ for sheets Nos. 7, 8 and 9 in the answer, as heretofore filed.

16

ARTHUR H. EWALD,
Counsel for Complainant
V. H. LOCKWOOD,
Counsel for Defendants.

Indianapolis, Indiana, January 11, 1916.

No. 2,703, of 1871 to Brannon.
" 4,335, dated Oct. 5, 1881, to Walter R. Kinnipple.
" 8,814, dated May 12, 1909, to Hennebique.
" 11,021, dated August 7, 1884, to Albert Hubner.

Letters Patent of France.

No. 228,177, granted Feb. 22, 1893, to A. M. Rau, for "Un procede pour la construction de parois, piliers ou constructions senables en charpente en fer et beton pise."

United States Letters Patent.

No. 87,569, dated Mar. 9, 1869, to George H. Johnson
" 88,547, dated Apr. 6, 1869, to Francois Coignet.

Other Publications.

1. In the book entitled "Tijdschrift van het Koninklijk Instituut Van Ingenieurs," published on or about February 1, 1894, at Te'S-Gravenage, Holland, by Gerge. J. A. H. Van Langenhuysen, special reference being made to the printed report therein of the proceedings of said institutut on November 14, 1893, and to the article published therein of R. P. J. Tutein Nolthenius on Monrier concrete constructions, and discussions thereon, to be found on page 39 to 53 and plates 11 and 111 of said book, and also said publication for the years 1895-96, and particularly Fig. 6 of Plate 2 of said publication and reading matter descriptive thereof, being part of an article entitled "Belastung mit Monier Platen," by R. P. J. Tutein Nolthenius.

2. In the book entitled "Concrete Constructions" by F. Rehbein, Royal Architect of Germany, published in 1894 at Berlin, Germany, said book being entitled in the original language "Ausgewahlte Monier unde Beton-Banwerke. Actien Gesellschaft fur
17 Monier-Beton." 2e Auflage and particularly the last figure on Plate 8 and the reading matter relating to the construction in said figure.

3. In the book entitled "Deutsche Bauzeitung, Achtundzwanzigster Jahrgang," published in Berlin in 1894, by Prof. M. Moller, and particularly Figs. 25 to 28, appearing on page 621 in the issue of December 15, 1894, Number 100.

4. In the book entitled "Centralblat der Baurer waltung," published at Berlin in 1895, and particularly the article by Moller on page 482 and the illustrations on page 428.

5. In the book entitled "The Engineer," Volume 1, page 398, published in London in 1895, and relating to an article on the Wunsch System by Robert Wunsch.

6. In the book entitled "Civil Engineering," by W. J. M. Rankine, published in London, 4th Edition, 1865, and particularly page 402 thereof.

7. In the book entitled "Annals de Travaux Publics de Belgique" published in 1898 at Bruxelles, Belgium, by J. Goemaers, special reference being made to Volume 55, pages 841 to 842 and Plate XXXIII, and to the article thereon entitled Revetment de talus en beton arme.

8. In the book entitled "Le Geine Civil," published at Paris, France, on February 11, 1903, Volume *on* Tome XXXIV, Plate XV. (Fig. 3.)

9. In the book entitled "Le Genie Civil, of Nov. 12, 1898, (No. 857) pages 22-24; of Nov. 26, 1898 (No. 859) pages 57-58; of Dec 3, 1898 (No. 860) pages 86-88; of Dec. 17, 1898 (No. 862) pages 103-105, all published at Paris, France, on the dates mentioned.

10. In the Book entitled "The Monier System" (Iron and Steel with Concrete Filling) in its Application to Building, by A. Seydel & Co., published 1887 at Berlin, Germany.

11. In the book entitled "The Engineer," Vol. 79, pages 395-399, published at London, England, May 10, 1895.

12. In the book entitled Le Ciment, published at Paris, France, in 1896, Vol. 4, dated Sept. 25, 1896, pages 105-110.

13. In the book entitled "Rudimentary Treatise on Foundations and Concrete Works," by E. Dobson, published at London, England, 1850, pages 1 to 25.

14. In the book entitled "Annalles des Ponts et Chaussees," Sixth Series, Volume 18, Second Half, Published in Paris, 1889, with particular reference to pp. 49 to 128.

15. In the book entitled "Le Genie Civil," Vol. 28, pub-
18 lished at Paris on the 12th of December, 1895, with particular reference to page 123.

16. In a book entitled "La Construction Moderne," by P. Planat, Vol. 9, published at Paris, France, 1893-1894, particularly pages 610 to 612, presenting an article by P. Planat on "La Theorie de Ciments Armes"; also a book being Vol. 11 of the same publication published at Paris, France, 1895-1896, particularly pages 621-623, being an article by P. Planat, entitled "Consultations Technique."

17. In a book entitled "Proceedings of the Institute of Civil Engineers," Vol. 17, published 1881-2, at London, England, particularly part 3, pages 197 and 234, relating to an article or discussion by Atkinson.

18. In a catalogue by Wayss & Co., published at Berlin, Germany, in 1895, particularly page 47 and following pages.

8. These defendants further say, upon information and belief, that the retaining walls and like constructions containing the improvements in all substantial and patentable respects similar to the alleged improvements claimed in said letters patent No. 705,732, were known to and publicly made, sold and used in the United States by many persons prior to the said alleged invention of the said complainant, and more than two years prior to the date of his application for said letters patents, particularly by the following persons and at the following places, to wit:

In the United States District Court for the District of Indiana.

In Equity.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Stipulation.

It is hereby stipulated by and between the Solicitors and Counsel for the respective parties in the above-entitled cause, as follows:

1. The defendant built, before the filing of the Bill of
19-20 Complaint herein and subsequent to the date of the letters patent in suit, and has been using retaining walls as illustrated in the attached blue prints of bridges marked No. 252, No. 407, No. 408 and No. 420, and the retaining walls shown in the attached blue prints are typical of other retaining walls built and used by the defendant, although varying sometimes in dimensions.

2. A printed book or periodical may be proven by an exhibit being introduced in evidence consisting of a photographic copy of the title page showing the date thereof, and of such pages or portions of the book or periodical desired to be relied upon by the defendant, including with cuts or drawings the reading matter relating thereto, with the same force and effect as if the book or periodical were introduced in evidence; and the date or year printed on the title page or at the tops of the particular pages introduced, or the date appearing in the title of a book, as set forth in a certificate by the Commissioner of Patents, or the date of the reception of any such publication in the Scientific Library of the Patent Office, as stated in a certificate of the Commissioner of Patents, shall be deemed to be the correct date of publication of such book or periodical, subject to evidence to the contrary, and a translation of any such portion of a book or periodical certified by the Commissioner of Patents to have been made by the official translator of the Patent Office shall be deemed correct, subject to evidence to the contrary.

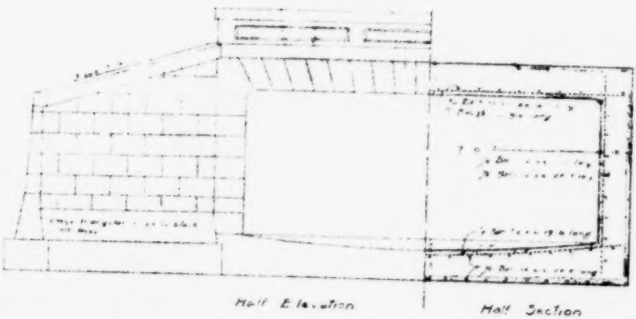
3. Official printed Patent Office copies of the specifications and drawings of United States patents and foreign patents, or photographic copies of such foreign patents when certified by the United States Commissioner of Patents, may be introduced in evidence as prima facie proof of the originals and with the same force and effect as if duly certified, subject to correction by evidence to the contrary, and the dates of issue or application appearing on any such letters patent shall be considered as correct, subject to correction by evidence to the contrary.

ARTHUR H. EWALD,
Counsel for Complainant.
V. H. LOCKWOOD,
Counsel for Defendant.

Indianapolis, Indiana, January 11, 1916.

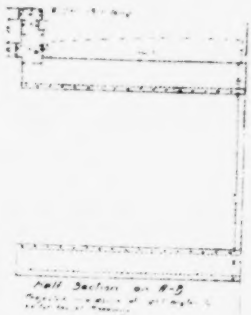
(Here follow diagrams marked pp. 21, 23 & 25.)

No 371
Bono
V.
Marion County
} Ø. 21



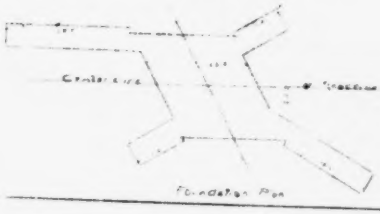
Half Elevation

Half Section



Half Section on A-B

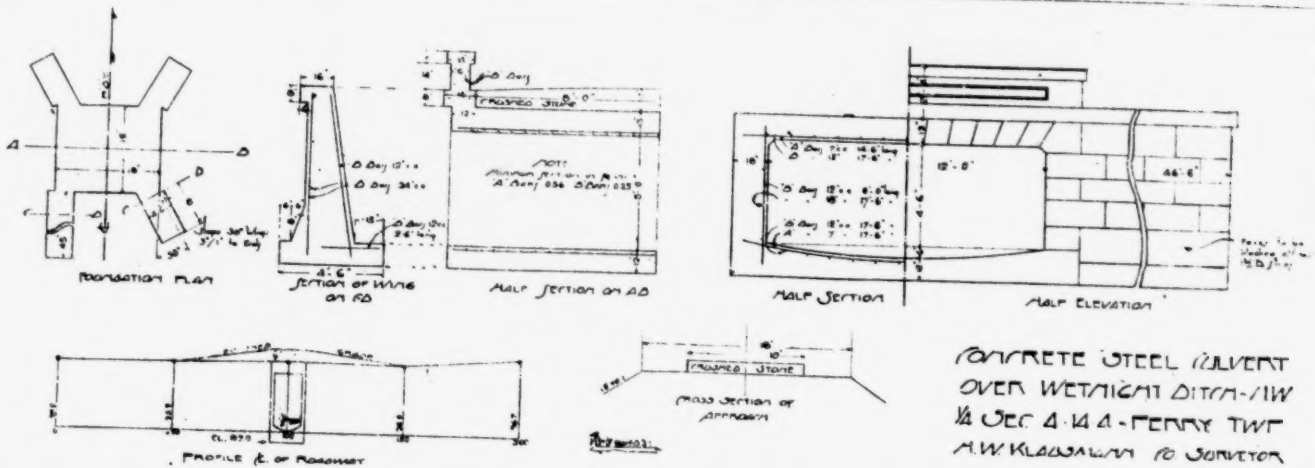
Section of Wing on C-D



Foundation Plan

CONCRETE STEEL CULVERT
OVER DRAINAGE DITCH ON HIGHLAND AVE.
DEL 20 TOWNSHIP CENTER TWP
IVY [illegible] COUNTY INDIANA

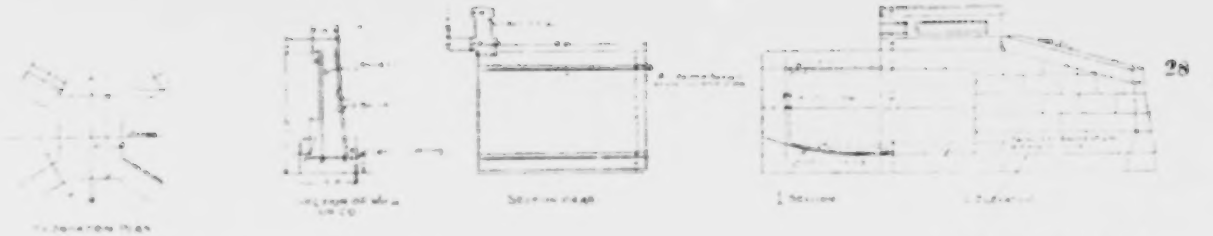
252



CONCRETE STEEL CULVERT
OVER WETMICAT DITCH-NW
¼ SEC 4-14 4-FERRY TWP
N.W. KLAWATTAN TO JOHNSON

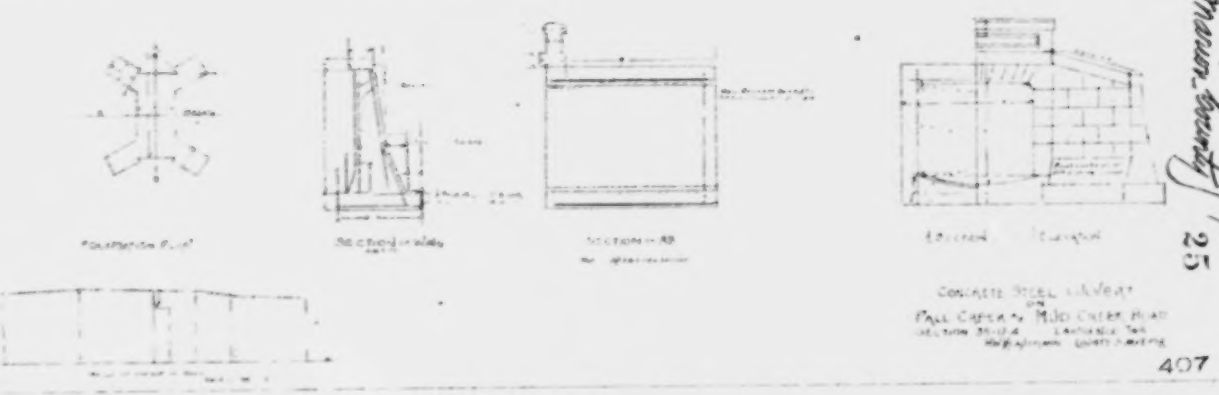
420

371.
Bone
v
Marion County } $23



28

406



Kane & Mason Counties

25

407

27 (Deposition Of Dr. Vos And Copies Of Publication Therein Not On File.)

In the District Court of the United States for the District of Indiana, November Term, 1916, December 22nd, 1916.

No. 7293.

In Equity.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Before the Honorable Albert B. Anderson, Judge.

Condensed Statement of Evidence.

Filed Dec. 27, 1916.

Come now the defendants by Messrs. Lockwood & Lockwood their attorneys and lodges a statement of evidence herein.

And afterwards to-wit, at the November Term of said Court on the 27th day of December, 1916, before the Honorable Albert B. Anderson, Judge of said Court, the following further proceedings in the above entitled cause were had, to-wit:

Come now the complainant by Messrs. Ewald and Sharman his solicitors and files his condensed statement of evidence herein, duly approved by the Court in the words and figures following, to-wit: (Here insert.)

28 *Testimony of Frank A. Bone.*

Duplicate.

In the District Court of the United States for the District of Indiana.

In Equity.

No. 7293.

FRANK A. BONE, Complainant,

vs.

BOARD OF COMMISSIONERS OF MARION COUNTY, INDIANA, Defendants.

Testimony in Narrative Form.

FRANK A. BONE:

Mr. Frank A. Bone, a witness on his own behalf as complainant, testified: I am a civil engineer and reside at Cincinnati, Ohio, and

am the complainant in this cause, and the party to whom Letters Patent of the United States, No. 705,732, were issued on July 29, 1902, and am still the owner of said Letters patent.

Testimony of William K. Eldridge.

WILLIAM K. ELDRIDGE:

William K. Eldridge, a witness called on behalf of the complainant testified: I am fifty-seven years of age, a civil engineer and architect and reside at Indianapolis, Indiana. I took the degree of civil engineer in 1878, since which time, I have been engaged in the general practice of civil and structural engineering; have been employed by various railroads in various services along the lines of my profession, particularly in the construction of bridges and buildings; in 1894 I was appointed city civil engineer of Lafayette, Indiana, which office I occupied for seven years, acquiring a general experience in all classes of sewerage, grading, pavements, sidewalks, bridge abutments, park work and water works engineering, and in these various works, cement and concrete were used to quite a large extent. I resigned as city engineer of Lafayette in 1901, and came to Indianapolis to take charge of the construction of a large
29 building in which the floor system was of reenforced concrete. Subsequent to the completion of said building, I designed portions of two large buildings of reenforced concrete. In 1906, I designed the Board of Trade Building in Indianapolis, including the skeleton construction of reenforced concrete columns, girders, beams and floor and roof slabs. Since that time, I have been engaged in designing heavy commercial work, power houses, electric railway sub-stations and car houses, etc., in which reenforced concrete members were used. I am a member of the American Institute of Architects, Indiana Chapter, of the Indiana Engineering Society and of the Indianapolis Architects Association, and have prepared and delivered papers at the meetings of such societies on engineering and allied subjects and have contributed to engineering periodicals.

Referring to the blue print of wall No. 252 attached to the stipulation in this suit, the witness testified: I have examined and understand the same and have compared the same with the Bone patent No. 705,732 in suit. The witness compared the construction of said wall with claims 1, 3, 5, 16 and 17 of the patent as follows:

"This shows a vertical retaining wall, and the earth to be retained by this wall is on the left, and a faint smudgy line up near the top of the wall to the left of it shows the top of the earth supposed to be retained by the wall. There is a similarity in this wall, we claim, each one being a combination with the retaining wall having a heel which is the projection at the bottom towards the left in 252, a metal structure embedded in said wall and obliquely in said heel. These would be bars shown in dotted line toward the right edge of the projection which angle toward bars running down to the left close to the oblique direction of the heel and into the foot or back so that the weight of the structure will operate to retain the wall in

a vertical position. That has the downward portion inserted (referring to blue print) which tends to counterbalance the horizontal portion of the wall towards the right.

"Claim No. 3 recites a combination, a retaining wall having the inclined heel and the metal structure just the same as claim 1; more specifically it says it consists of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, in such a manner that the weight of the retained material upon the heel of the metal
30 structure will operate to maintain the wall in a vertical position.—A bent being a framework of vertical and horizontal bars intersecting each other, and the wall being built presumably in sections, there would be a bent in each section; or, if a very small wall, the metal structure would be composed of a single bent.

"Claim No. 5 merely differs from No. 3, in calling for a number of the bents, and also a portion of the bents carried along the heel in an inclined direction, which is shown on the photographic reproduction,—by the lower inclined bars intersecting the bars in the vertical part of the wall and running down into the footing.

"Claim No. 16 is a combination with a retaining wall having a heel and a toe,—in that differing from the preceding claims with that addition of the toe. This is the projection of the footing at the right in the drawing opposite the corresponding projection at the left. The toe has an independent metal structure embedded therein. That is shown in the drawing at the bottom very close to the base line of the drawing, a series of bars said to be on the drawing, one-half inch bars, twelve inches center to center, fourteen feet long, intersected by other horizontal bars at right angles thereto, which constitutes the metal structure in the toe, in addition to that metal structure embedded in the wall or heel, just the same as in the preceding claims; so that the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in a vertical position, as explained before.

"Claim 17 is a combination claim, a retaining wall having an inclined heel and a toe,—differing from 16 by specifying that that heel is inclined. It has an inclined heel and a toe at opposite sides there—that is, that that toe is opposite the heel—and of a metal structure embedded within said wall and heel, for the same purpose of keeping the wall up. These are the five claims to be construed."

Referring to wall No. 407 as shown in the drawing attached to the stipulation, the witness testified: I have compared the same with the claims of the patent in suit and found it to be substantially identical with wall No. 252 and that the said wall No. 407 infringes claims 1, 3, 5, 16 and 17 for the reasons given above.

Referring to wall No. 408 attached to the stipulation, the witness testified as follows:

"I have examined the drawing No. 408, and find the retain-
31 ing wall shown there, the sectional drawing, is entitled "section of Wing on C.-D.," and this drawing differs from the preceding ones in not showing the inclined heel. It shows an

incline connecting the face of the wall with the toe, apparently, but not the inclined heel; but it does show bents and bars running close to the back of the wall down into the heel and intersected by the metal construction of bars in the heel. In that case the infringement would be of claim 16 alone."

Referring to wall No. 120, attached to the stipulation, witness testified that the same does not show the inclined heel or any metal structure in the heel or toe; and that in his opinion, none of the claims are infringed by wall No. 120.

Relating to the patented wall and in response to interrogatories by the Court, the witness testified as follows:

The Court: Do you think it involves invention to put a toe in the wall and extend the reinforcement down into the toe?

A. Yes, it is something that never was done before and it shows utility in that it permits the toe to be extended further than it could be without the reinforcing.

The Court: Where is the inventive idea? Where is the conception that rises to the dignity of invention?

A. It seems to me to be a combination of various elements that set together to obtain the unitary result.

The Court: He was not the first man to reenforce a wall?

A. No, indeed.

The Court: He was not the first man to conceive the idea to put heels or toes on the wall to get the benefit of the weight on it, was he?

A. No, sir.

The Court: Then what was his invention? What was he the first man to do?

A. He was the first man so to reenforce these walls in the particular manner he did.

The Court: What is peculiar about that?

A. The inclined heel, mainly.

The Court: In this shape?

A. This shape; the inclination of the heel which permitted him to save a large quantity of material.

The Court: Do you think the idea was that if the base was wider he knew that the wall would stand better? Everybody knows that the wider the base the better it will stand.

A. This was a cantilever wall; not its stability alone.

The Court: I know; but the idea is to have a wall that will not topple over or break.

32 A. Yes, sir.

The Court: But the building of the heel and toe so as to get a wider base is in order to get the benefit of the earth that is on here to keep from tipping over?

A. Yes.

The Court: I do not understand a man can make an invention by changing the shape of the parts of the wall. Now, if the only thing that distinguishes one of these claims from some other is the incline of the heel, you do not say that involves invention, do you?

A. Yes, in this sense, your Honor: By putting the incline on the

back in such a manner as to put your dangerous point,—the point where ruptures are most likely to occur,—higher up, nearer the top, you gain in the proportion of eight times the change. That is, if you were to have a wall ten feet high, beyond the base and then if you were to put your incline so that the top of the heel is eight feet high, your change is ten to eight, but your benefit is about one hundred and fifty. The gain then, is the saving of expense in being capable of using less concrete and considerably less steel to resist the stress than it would be otherwise.

The Court: Do you mean this incline?

A. That incline, yes.

The Court: It looks to me like mechanics.

Mr. Eldridge said, on cross examination by Mr. Lockwood:

The Bone patent shows a unitary frame for reenforcing a concrete wall formed of parts metallically and rigidly connected. The Marion County wall No. 252 has plain bars of the same size and character, instead of using artificially shaped metal bars. The ordinary construction now-a-days is in some manner to anchor them by twisted wire or in some way to keep the same from displacement while the concrete is being put in. I do not believe that in building the Marion County wall they put in the metal bars as they *build* up the concrete, as it would not look sensible. The drawings and blue prints of the Marion County wall do not show these bars secured together by metallic means, wire or anything of the kind, but show them merely overlapping each other. I do not know personally what method was used in constructing the Marion County wall. An intelligent foreman would attach the bars together by clamps or wires to hold them in place before the concrete is put in the mold.

If the upper part of the inclined reenforcing bar and the vertical reenforcing bar were wrapped around two or three times by wire or a twine strong enough to hold them in place in the mold before the concrete is put in, the tie would not serve very much to transfer the tension or stress from the heel or base to the upright part of the wall, but as soon as the concrete is poured in and hardened, it would. The temporary tie of wire or string would not tend to make the frame rigid. In the Marion County wall individual bars are put into the wall and overlap each other and there is no unitary frame except as it becomes one as soon as the concrete is hardened, on account of the grip of the concrete and the individual bars are held in position by the concrete. In the Bone construction the reenforcing frame is rigid, but I do not think it tends to support and hold the concrete but to reenforce it.

If I remember the drawing of the Marion County wall No. 252 correctly, there are horizontal bars in the lower third of the wall as well as in the heel, but none in the vertical part of the wall. In Marion County wall No. 420 there are no longitudinal bars associated with the vertical bars except at the top of the wall.

A "bent" is a frame made before the concrete is put in place and either made in the mold or outside of the mold and put in the mold

before the concrete is put in. It is a frame or structure built outside or in place. These retaining walls of any length, are usually divided into sections, possibly twenty feet long, separated from each other by expansion joints and I think in reenforcing each section would constitute a bent. The portion in Figs. 2 and 3 of the Bone patent is one of the elements of the bent. The bent is a unitary frame which may have a plurality of reenforcing bars. Each of the claims to which I have referred specifies "a metal structure." If they put the concrete in and lay in the rods at regular intervals without fastening them together, it would be a metal structure, but practically it is not done that way. The patent contemplates the reenforcing of the concrete by distributing the reenforcing through the several parts of the wall where it would do the most good.

The invention set out in the claims does not apply to every wall having the upright portion and the heel portion with metal reenforcing throughout the upright and the heel whereby the weight of the earth on the heel would tend to maintain the upright vertical.

Such a wall could have reenforcing placed in it so as to
34 become an entirely different thing as a unit. I think it involved invention to put reenforcing where the strain is on the date the application for patent was made and economizing the matter by putting in the concrete in the particular manner specified in the patent. I do not understand the utility of the patent is denied.

I think there were no disclosures previous to Mr. Bone's invention that would include all of the elements in the one patent, that is the idea of making a retaining wall with vertical and horizontal portions and metal reenforcing for those portions, whereby the weight of the earth on the heel would be transmitted to the vertical portion and tend to hold it upright. That is my understanding of the invention in these claims. One of the features of the invention set out in the claims consisted in putting reenforcing in to transmit the tension from the heel to the upright and another feature so to incline the heel that the critical point, the junction of the upright stem where it would be apt to break off, is put higher up. That lessens the horizontal pressure of the earth in proportion to the square of the weight pull, and the resistance of the shorter stem is increased in its own proportion, so the gain is as to the cube of the height.

One of the elements of the invention consisted in inclining the heel so that it would reach higher on the wall, but if you go up too high without widening the base, you neutralize the benefit of it. Claim 1 does not speak of an inclined heel, but it speaks of a metal structure embedded obliquely in the heel, so that by implication would call for the inclined heel. Otherwise you would waste the material.

Wall No. 408 does not show an inclined heel, but it infringes claim 16 which speaks of having a heel and toe at opposite sides. Wall 408 shows the equivalent of claim 16 in the disposition of the reenforcing rods. It has a heel and toe at the opposite sides, and an independent metal structure in the toe from these small dots

(referring to drawing), which I take to be bars, the metal structure is embedded within the wall and the heel. From the looks of the drawing of wall 408, I suspect that there were no connections between the bars in the toe extending longitudinally in the wall and between the cross bars, they were entirely separated from each other so they could not be called a framework, but the claim says, "Said toe having an independent metal structure embedded therein." In wall 408 I see two dots which I take to be metal structures running longitudinally along the concrete and so far as I can tell from the drawings, they are independent from any other part and from each other.

On redirect examination, the witness testified: The "framework" of the Bone patent is not in itself a self-supporting structure, but that without the masonry, the same would fall over. The wall disclosed in said patent is of what is known as the vertical cantilever type; the bars of defendants' wall No. 252 serve the same function as the metallic construction in the patent and the wall of the patent and said wall No. 252 are of identical types; and in the metallic constructions of the wall of said patent and said wall No. 252, "equivalent means are used in the same manner to produce the same result."

If the respective parts overlap each other and extend further on into the concrete a sufficient distance to obtain the full virtue of the adhesion of the concrete, and the full value of the tension stress, then it is just the same as if they were riveted together and the protruding ends cut off. Such practice is very frequently resorted to in the art of reenforced concrete, if the ends of the bars are deep enough in the concrete to get the full effect of the grip, and that equivalency is now known in the art of reenforced concrete.

Mr. Lockwood: I understand then, that you do not claim that bridge 408 is an infringement.

Mr. Ewald: That is one that the record shows is not an infringement.

The Court: Which walls do you claim infringe?

Mr. Ewald: Nos. 252, 407, 420. (Wall 420 was named through error, wall 408 being intended). Those are all typical of other walls built by the defendant.

Defendant's Evidence.

Testimony of George M. Fritz.

GEORGE M. FRITZ testified as follows:

I live at 445 Sanders Street, Indianapolis, Indiana, and am 39 years old and a contractor. My business has been to build bridges and wing walls for bridges for ten years past. I have built a bridge like No. 252, for Marion County. In building these bridges we would pour the footing, that is, the lower part; then we would build the form and pour the upper part. We would put in the metal reenforcing just as we went along. It consisted of corrugated steel

bars introduced in the walls separately and independently of
36 each other as the wall is built up.

No cross-examination.

Mr. Lockwood offered in evidence the following prior patents as "Defendant's Exhibit, Copies of Patents":

British Patent to Brannon, of 1874, No. 2,428.
U. S. Patent to Francois Coignet, No. 88,547.
U. S. Patent to Alphonse De Man, No. 606,988.
U. S. Patent to Adam Geisel, No. 597,281.
British Patent to Hubner, of 1884, No. 11,021.
U. S. Patent to Peter H. Jackson, No. 462,437.
U. S. Patent to Franklin Haines, No. 508,308.
U. S. Patent to Charles F. Stowell and Andrew C. Cunningham, No. 629,477.
U. S. Patent to Guy B. Waite, No. 606,696.

Testimony of W. K. Hatt.

W. K. HATT testified as follows:

I am professor of Civil Engineering and director of the Laboratory for Testing Materials at Purdue University, and I am 47 years of age.

I graduated from Cornell University with the degree of Civil Engineer in 1891; I have been at Purdue University since 1893; there my duties have been to teach the subject of masonry construction, design of masonry structures; to investigate and make reports on reenforced concrete tests in the laboratory. I have also carried on the practice of a civil engineer in connection with my duties. I have designed and superintended the construction of reenforced concrete buildings. I have made calculations upon about a dozen reenforced concrete buildings for concrete contractors, and I have served on four commissions appointed by the building Commissioner of the City of Chicago to draw up regulations governing the design of reenforced concrete buildings. I have made reports upon concrete arch bridges and their reenforcing. I have made particular investigations in 1902 of the principles of action of reenforced concrete and I have written many papers on this subject. I was also a member of the National Advisory Board of Fuels and Structural Materials, appointed by one of our former presidents. I am a member of the American Society of Civil Engineers, and a member of their Committee on Concrete and Reenforced Concrete; am Vice President of the
37 Concrete Institute. I have given testimony in patent law-suits. I was chairman of the Board of Engineers for the concrete bridge at Lafayette that constructed the Main Street bridge. I have not built concrete walls of reenforced concrete construction.

I have examined the patent in suit to Frank A. Bone and understand it. I will state very briefly and not completely the history of the art of reenforced concrete construction preceding the Bone patent:

Francois Coignet appears to have taken out a patent in 1869, in which the disclosure is made of the fundamental idea of reenforcing concrete with iron or metal embedded in the structure as made. His patent describes the use of those irons, the metallic skeleton in the concrete, so that the thickness of the walls were or might be considerably reduced and yet great strength be obtained.

"Such, for example, would be the construction of a cylindrical web of small rod-iron or wire, upon and around which artificial-stone paste may be agglomerated so as to obtain water-pipes capable of resisting an interior pressure, which is so necessary in such pipes. Again, in the construction of troughs or water-vats angular-bent iron L-shaped pipes may with good effect be introduced in the body of the material to give greater strength to the angles and prevent the trough from spreading asunder at those points."

And in his claims, especially in 2, he claims:

"The introduction, in the body, of artificial stones, or in the body of artificial-stone monolithic structures made of agglomerated artificial-stone paste, of skeletons, or metallic frame-work, linked or arranged so as to strengthen the same, substantially as specified."

Now, that is a disclosure of the fundamental principle of reenforced concrete.

I pass by to pick up the work of Thaddeus Hyatt, who has a book printed for private circulation in 1877, and deposited, he says, in his patent, in the Patent Office Library. He made a number of experiments on beams reenforced with steel, in various amounts and disposition, and from his experience he draws rules for design, and he discloses in his publication and gives a clear opinion of the mechanism of actual stress in such structures. Hyatt was not only a writer, but an inventor, and he it was who put the idea of Coignet into mechanical shape. The history of reenforced concrete
38 from 1877 to 1887 is very meager.

Monier in France got a patent which was bought by a German named Wayss under the name of Wayss & Company, and from 1887 to 1897 the art of reenforced concrete construction in German- and Austria proceeded with great rapidity.

I have here certain extracts from a publication issued by this company operating in Germany and Austria under the firm name of Wayss & Company, entitled "Ausgewahlte Monier-und Beton-Bauwerke," which has a description and a showing of the designs and structures that that firm had built. They have over thirty bridges illustrated and described. Now, this catalog was published in the year 1894, was prepared by a man named Rehbein, an official in Germany, and the translation is attached to the article. I call particular attention to page 10 and plate 8, and the table, on page 20, which refers to the structure illustrated on plate 8. Plate 8 shows a bridge, an under-crossing, and wing walls—the wing walls supporting earth pressure. The wing wall is shown in cross section in the lower right-hand figure of plate 8. It shows the wall, with the vertical portion and the base, the two being connected by reenforcing. The weight of the earth on the base is transmitted longitudinally

along that base. Connection between the base and vertical is concentrated in what is sometimes called a counterfort. This wing wall, resting on its own base, and acting by the stability added to it by the weight of the earth on the base, is a reenforced concrete retaining wall, with a heel but no toe. It rests on a foundation of gravel,—tamped gravel. I call attention also to the figure on the top of plate 8 in which an arch opening is reenforced also on its bottom so as to prevent the bottom from cracking to prevent the water leaking in.

Now that base has a projecting portion reenforced as a toe to withstand the upward pressure of the foundation. That reenforcing is embedded therein to reenforce the structure. The title there states that that was built in the year 1891.

I also refer to an article by Professor Möller, of Brunswick in a periodical called the Deutsche Bauzeitung published in the year 1894, and to page 621 and Figures 25, 26, 27 and 28. The author was a well known investigator and builder and he has designed here for experimental purposes two retaining walls which, as he discloses in his article, operate for stability by reason of the weight of the
39 earth on the heel. The first one shown, Fig. 25, is to the left; and in Fig. 26 to the right. It has longitudinal bars running at the middle of the height, and at the top. The cross bracing is concentrated in these two ribs (indicating) and these are strengthened by the insertion of wires, the wires shown being the dotted line going from the top of the wall down to the back of the heel, and the other from the middle of the wall back to the heel. These walls have also what the author calls earth-anchors, which are piles of concrete in the ground, and the wires run down into those. They are placed there for additional stability. The wall is designed for strength.

He next designed and tested a wall shown on the right-hand, Fig. 28, a wall without ribs,—which is our definition of the cantilever wall, designed for strength. He evidently knew what he was doing. The cantilever retaining wall on the right has no reenforcement, so far as the article discloses. The author seems to suggest in a portion of his article the use of reenforcing in such wall, but the disclosure does not clearly appear.

These two, then, are disclosures of concrete walls operating by the weight of the earth on the heel, the one having its bracing connecting the vertical with the horizontal, and the other having the bracing simply of the increased thickness of the concrete where the vertical stem joins the wall.

I next call attention to an article by a Hollander named Nolthenius. Nolthenius' name is one of notable importance in the development of the art of reenforced concrete construction and theory prior to 1897. The article was published in the "Tijdschrift van het Koninklijk Instituut Van Ingenieurs,"—a journal of the so-called Royal Institute of Engineers of Holland. It appears in the publication, title page of 1895 to 1896. That portion of the article which is material here is on page 17,—the last paragraph on page 17, and the remainder on the next page. It refers, however, to the wall on Plate 2 covered by Fig. 6,—Figure 6 showing a cross section of the

wall on the left, and its plan immediately to the right. The author says that that wall was designed so that the moment of the weight of the earth pressure on the heel would be equal to the moment of its pressure against the vertical part of the wall, so its stability would be assured. He made such a wall and tested it, and the results are described in his article. Now that wall has a curved vertical
40 stem to give it an arch form. It carries the pressure on the vertical wall by an arch action. The reenforcing goes from the vertical stem over to the heel. This (referring to drawing) follows the definition of a wall resting on its own base, and operating by the use of the weight of the earth on the heel. The translation of the article is complete.

I next call attention to two articles by a French writer of voluminous output, named Paul Planat, who was editor of the magazine "La Construction Moderne." The first article appears in his newspaper in the issue of the 22nd of September, 1894. This article is one of a series of articles running through the year, in which the author lays out his theory of reenforced concrete, afterwards published in book form, and this particular article deals with retaining walls. He shows how to design the walls so that the base slab A-B may maintain equilibrium against the vertical slab, and the dimensions are fully set forth showing the design of his wall. The figure on page 611 discloses its nature. I have a model from the drawing of his wall. This drawing is a representation in perspective of the wall shown in cross section on page 611, Figure 1. The portion of the dimensions not shown on Fig. 1 I have taken from the article where he works out the wall in its dimensions. This wall in operation is as follows: It has a vertical portion and a heel which is inclined,—the vertical portion being also inclined. It has its strengthening members concentrated at two points; The weight of the earth on the heel travels longitudinally or horizontally to reach these ribs (indicating). The pressure against the vertical slab travels longitudinally until it reaches the ribs which act as cantilevers. This is a wall that is self-sustaining; resting on its own base, of reenforced concrete having metal bars of iron running from the vertical wall down into the inclined heel. The author discloses the whole theory of these walls. A model of the Planat wall is here exhibited. The nervures are shown, and the metal structure in the nervures or ribs running down.

Now the next reference that I have is an article by the same writer, Paul Planat, which appears in La Construction Moderne, under date of September 26, 1896, in which one of the subscribers writes to the editor asking him why the government engineers had built so heavy a quay wall, and asking the editor if he could not design a reenforced concrete wall with less material. He wants to know
41 what the dimensions of the new profile would be with the interpolation of bars, and thus to adopt a new profile type after the editor's learned theory of reenforced concrete. He also wants to know what the calculations would be to determine the diameter of the bars, and he wants to know what the economy would

be with those modifications. Then the editor makes a response and shows him how to design a cantilever wall. The article does that very completely, and the result is on page 623, the cantilever retaining wall reenforced with bars running down the face of the vertical stem in the top part and horizontally in the heel, that is in the top part of the heel.

The bars are placed where they take the tension. They are calculated to carry the load against the cantilever top and the cantilever heel. This wall operates by the weight of the earth on the heel. It rests on its own base. It is reenforced concrete, and is of the cantilever type in which bracing is taken care of continuously instead of being taken care of at special sections. The translation contains the complete article, and I will not take up the time of the Court by referring to special parts of it.

These are references to the prior art of reenforced concrete retaining walls. The model of the Planat wall, which I have just exhibited is on the table and it shows the bars passing vertically to reenforce the heel, and the bars passing vertically to reenforce the vertical portion, and, moreover, there is placed a sort of a toe on the front. Now, the author makes this suggestion in his manuscript, which is very important.* He says that it is important that these two cantilevers should be well fixed at the point of joining. He said it would better and more secure if they placed bars at 45 degrees embedded in the two separate walls. So that Planat discloses the necessity of putting in the inclined bars to lend support to the wall,—that was 1896, in September. His first wall was 1894.

The notion of using the weight of the earth as contributing to the stability of the wall is also old. I call attention to the standard work "Civil Engineering", by Rankine, this edition being the edition of 1865, in which on page 402 Rankine says:

"That the weight which rests on the base consists of the weight of the masonry together with the weight of the mass of earth, if any, which is vertically above that base."

He puts these words in italics, to call attention to the fact
42 that the weight of the earth above the base contributes to the stability of the wall.

That statement is also clearly made in the minutes of the "Proceedings of the Institute of Civil Engineers," under date of 1880-1, part 3, page 197. It is in a discussion by Mr. Atkinson in an article on Retaining Walls by Sir Benjamin Baker, builder of the Forth Bridge.

Mr. Atkinson says as follows:

"In that case, it must be borne in mind that there were two elements in addition to the theoretical calculations, namely, the projections of the footings where there was so much leverage, which was not taken account of in the theoretical calculations, and the weight of the earth resting on the projections or steppings at the back of the wall, Fig. 44. That, of course, aided the wall very materially; in fact, it might be called so much masonry saved."

This idea of the weight of the wall is old, as appears in Rankine.

in the Bauzeitung article, and it also appears in the patent of Stowell and Cunningham. I refer to page 2 of the file wrapper, or page 3, the last paragraph, where he says:

"The weight of the mass of material superincumbent above the foundation keeps the latter in place and prevents overturning, while the foundation itself is stiffened and strengthened by embedding in it iron or steel in the form of beams, channels or other suitable forms in order to prevent the foundation from breaking between the knee braces."

This Stowell and Cunningham patent operates by reason of the weight of the earth on the heel adding to the stability of the wall. It has in the vertical portion of the wall a continuous metal structure. It has in the heel certain stiff beams carrying the load along the heel to these concentrated bars (indicating on drawing) which are in this case in the form of riveted structures. This is a continuous metal structure in this form of wall,—the part of the structure running from the retaining wall to the horizontal heel. The author says that these continuous plates were put in to prevent animals burrowing through.

I also call attention to a very minor showing in the patent to Haines, November 8, 1893, No. 508,308, which is a curb wall, and, in a minor way may be said to be a retaining wall, which does have the vertical portion of the metal structure embedded therein continuing into the toe. The construction in the toe is not independent of the construction of the vertical wall. It is a retaining wall without the heel but with the toe.

43 I will show by many references the state of the art prior to 1897 in the art of reenforced concrete. The principles of reenforcing concrete were well known and practiced by practitioners such as Hennebique, Koenan, Coignet and Monier, and they had devised the methods of construction and development of a theory, seeming to have had the constructive sense in knowing where to take care of the strain in such walls. So, in 1897, while it was not understood in this country, it was a well developed art in Europe, and especially in Germany. That is important as applied to the prior art in this case.

The retaining walls shown in the Stowell and Cunningham patent, and the Rehbein wall and in the Nolthenius wall, and the Planat 1894 wall and the Planat 1896 wall, were structures of a practical character which would do the work and take the place of a retaining wall substantially like the wall shown in the Bone patent in suit. They would all carry the loads that they were designed to be loaded with. I make an exception of the second wall in the Bauzeitung, which practically has no reenforcement. I do not consider that to be properly a practical design, unless the concrete was made thick enough to take care of the strain without the steel.

The heel portion of this wall is long enough in proportion to the upright portion of the wall, that the weight of the heel transmitted to the upright would be sufficient to resist the stress of the wall against the upright.

The heel in most of these structures are longer and wider than the

heel of the Marion County wall. I might say that as a rule, the structures designed in Europe of reenforced concrete are much more constricted than ours, much thinner. Over there labor is cheap and materials are high; so their designs run on thin sections,—more labor required, more surface, less materials, whereas in this country our designs are for more material. It is a question purely of mechanics and the cost of labor involved.

The article about the Planat 1894 wall says by way of comparing that type of wall with the ordinary masonry walls, the following:

"We have no knowledge that reenforced cement has been yet applied to the construction of retaining walls. It would find there, however, an advantageous use. Walls of masonry have a volume very considerable, since they resist pressure by their mass alone; a mass rigid and elastic can necessarily have dimensions much more constricted and there may result a very sensible economy. Iron would have the same advantages but the metal employed would not be conserved in contact with the earth as well as iron buried in the cement where it has the valuable property of remaining for an indefinite time without any alteration."

The publication of the Planat 1894 wall refers to the equilibrium of the wall as follows:

"Let there be a wall to erect of a height *h* with a fill on the interior; we suppose this wall prolonged at its lower part by a horizontal base slab A B for the purpose of maintaining equilibrium."

The author of the article of 1896 on the Planat wall speaks of the necessity of fixing both branches of the wall at the juncture of the vertical and horizontal reenforcing bars, as follows:

"In constructions of this nature, it is evidently the fixation which exacts all the attention of the constructor. One can, however, consolidate it also by means of some bars placed at 45 degrees in the dangerous angle and embedded in the two perpendicular walls."

The opinion of the Circuit Court of Appeals of the Sixth Circuit stated:

"If the prior art had shown a structure intended for a retaining wall, and having a heel such that the weight of the earth thereon would tend to keep the wall erect, it might be difficult to find invention in merely adding the form of reenforcement most suitable to create the desired tensile strength; but we find no such earlier structures."

But the prior art about which I have testified relatively to this shows the following walls corresponding to the structure contemplated in the quotation from the Court of Appeals' opinion:

The Rehbein wall; the Bauzeitung walls, both of them; the Nolthenius; the two Planat walls; and the Stowell and Cunningham patent wall.

Mr. Lockwood offered in evidence a certified copy of the record in the case of the City of Akron vs. Bone, in Equity No. 128, U. S. Circuit Court of Appeals for the Sixth Circuit, and the same was marked "Defendant's Exhibit, Record of Akron Case."

Witness Hatt: I have examined the record in the Akron case and have not found therein any evidence of the prior art just mentioned in my last answer.

Mr. Ewald: It is admitted that they were not in that record, but there are plenty of others that are there. The ones that he has specifically referred to are not in that record. They were,
45 however, before the Court on the application for a rehearing, and the Nolthenius and Stowell and Cunningham patents were before the Court in Denver.

Witness Hatt: The opinion of the Sixth Circuit Court of Appeals stated:

"Those which have that shape"—

referring to the last quotation:

"are sustaining walls only, and were so obviously unfit for use as retaining walls that no one seems to have seen the utility for that purpose, of which the form, when properly adapted and strengthened, was capable."

The new references or walls above mentioned, not found in that record, are all retaining walls.

The opinion also states:

"There is also a prior wall, wholly of metal, fairly disclosing a unitary heel adapted to hold the wall erect; but to see that this could become merely a skeleton embedded in concrete may well have required, in 1898, more than ordinary vision."

I do not know what the Court means by the word "skeleton." A skeleton is an assemblage of bars,—bones of the body, as you may refer to it, and if used in that sense, then I might say that the reenforcing bars of all these walls constitute a skeleton. They are in that sense a skeleton. It is common in these French publications to refer to these as skeletons—"ossature" is the word, "collection of bones." So I might say that it did not require unusual vision to embed the bars in concrete.

If, in the opinion of the Court, the word "skeleton" means a connected system of reenforcing, then we can cite references in the prior art where the concrete or stone is reenforced by a structural steel frame-work in which the metal is continuous and the structure is an assemblage of metal parts rigidly connected together. There are such structures in the prior art, as I have stated.

The patent in suit makes the following statement:

"I am aware that retaining walls have been constructed of concrete and steel, but none to my knowledge have been supported on their own base as mine, nor have any of them entirely inclosed the steel within the concrete, nor have any of them used the weight of the material retained as a force to retain itself."

I think that those three novel features are all met in the prior art stated; namely, Rehbein, Nolthenius, Planat, both walls, and the Bauzeitung references, although the last I think is some-
46 what weakened by the presence of that earth anchor which the author says is an element of increased stability, but that he has provided for their full stability by the design of his base.

I think each of these walls cited will meet everyone of those claims except the second one in the Bauzeitung. Everyone of the anticipatory patents combine all three of the new features specified in the patent.

In the first part of the patent in suit it is stated:

"The said invention consists principally of introducing into masonry of concrete, stone, or brick a framework of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base, and strength against overturning, bulging, or settling will still be ample."

If the frame work is the ordinary frame, which means an assemblage of members rigidly connected together, then not one of these references fills that definition of framework. But if a network of members, as the Monier mesh, or an assemblage of members tied together, or some assemblage of those members, can be defined as a framework, then each one of them meets the statement.

The Court: Why does not this one meet it according to your opinion "on the framework jointed and fastened together"?

A. I think that is so, sir, the Stowell and Cunningham meets that definition it meets my definition of a framework. I do not think the others are frameworks.

Referring to the claims of the patent in suit involved here and confining my attention to the words and not to the description or drawing of the patent, the structure, is, first of all, a combination of the related parts and is a metal structure, the parts being connected together by metal.

Referring to claim 1 of the patent in suit, it is extremely difficult to ascertain the meaning of that claim as it is expressed. In the first place, there is the requirement that the weight shall rest on the heel of the metal structure. How is that possible unless there is some member running longitudinally in the heel to take up the weight of the retained material and carry it over and let it rest on the heel of the metal structure; as the member I in Bone's patent. The member I takes the weight of the retained material B and carries it to the heel of the metal structure. The Stowell and Cunningham wall, I think, does that. So I cannot see how it can be said
47 that none of these walls cited take the weight of the retained material and carry it to the heel of the metal structure.

Again it requires that this metal structure shall run obliquely into the heel. I do not find that in the Stowell and Cunningham structure unless it should be said that these oblique bars run obliquely into the heel. The Planat 1894 wall has metal bars embedded obliquely in the wall and running obliquely in the heel, but I cannot think that these single bars constitute a metal structure in my definition of the term. The Planat 1894 wall comes the nearest to meeting claim 1 and if the bars in these ribs are metal structures in the sense of the words of the patent, then this does meet claim 1.

If a metal structure be considered independent bars embedded in the concrete and connected by the concrete or the concrete bond, in the meaning of that claim, I think the Planat 1894 wall meets it and

also the Planat wall of 1896, after the suggestion of the author has been admitted that an inclined bar be placed at 45 degrees at the dangerous angle. I do not think that in any of the other references it can be said that the metal structures run obliquely into the heel.

Referring to claim 3, it demands an inclined heel, and that is supplied in the Planat 1894 wall. There is a metal structure imbedded in said wall and heel, consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall so that the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in vertical position. The Planat wall of 1894 is the only one of these structures which has an inclined heel, excepting in so far as we consider that this inclined bar or brace suggested by Planat in 1896 may wholly suggest the construction of this inclined filling in which that bar was embedded. The word "bent" is defined in the Standard Dictionary—as "A section of a frame building; a portion of a framework or scaffolding of a building put together on the ground and raised at one time." That is my understanding also of the word "bent," and that word does not convey to me any vision of loose bars put in concrete as is the custom. The upright bents perhaps suggest the Stowell and Cunningham construction.

Defining the word "bent," as I did, I do not find that any of these walls will answer to the description, but if the words "upright bent" be conceived of as meaning an assemblage of loose bars in concrete, as they ordinarily use them in construction, then I think the
48 claim is met by the Planat 1894 wall which has an inclined heel, which has a metal structure as defined in the previous question, and it is embedded in the back part of the wall and continues down along the upper part of the heel to the back part thereof, in such manner that the weight of the retained material operates to maintain the wall in vertical position.

Referring to claim 5, it is the same as claim 3 excepting that the inclined heel is not demanded and the metal structure continues down in an inclined direction. I say again the application of this claim depends entirely upon the definition of the words "metal structure" and "upright bents." We will assume first that the metal structure means a combination of related bars, rigidly connected, continuously by metal, and the words "upright bents" means a framework built and then installed. With these definitions, I do not find any one of these walls answering that description. But, if the metal structure be conceived as a combination of loose bars operating, not alone by the strength of the metal, but by the strength of the concrete also and that the upright bent may be an assemblage of such bars, then the claim is met by Planat 1894 wall which has a heel, with the metal structure embedded, and it has these bents at the back part of the wall, and they continue down the upper part of the heel in an inclined direction. It also would be met by Planat 1896 wall, if the suggestion of the author is adopted, that the inclined bars be inserted. Both the Planat 1894 and 1896 walls, if the inclined bars be inserted in the latter, show reenforcing which

continues in an inclined direction down along the upper part of the heel.

Referring to claim 16, it has a heel and a toe, with a metal structure in the toe, and the metal structure in the wall and the heel. The metal structure in the wall continues in the back part down along the upper part of the heel. This structure is again an upright bent. The heel is not necessarily inclined. Again, the weight of the retained material is on the heel of the metal structure. Referring to the prior art, we have no reenforced concrete retaining walls that I have cited showing a reenforced toe as Bone reenforces it. The Möller walls in the Bauzeitung reference both show projections on the face of the wall which would operate in some sense as toes and do not project far enough to demand reenforcing. In Planat 1896 wall he shows what he calls "salients" or projections
49 which would operate as toes when the walls are loaded. These are not reenforced for tension, and I have no structure with such a reenforced toe.

The reenforcing in the Planat 1896 wall extends into the toe part of the wall. They do not reenforce the toe of the wall against the toe action of that projection, and they are not independent of the structure in the heel.

I think there is no virtue in having reenforcement in the toe independent of the other reenforcement of the wall,—as a mechanical function. It is my opinion the reenforcement of the toe is decidedly a thing which anyone, such as a mechanic skilled in the art, would adopt if he found that the toe were weak. I call attention to the reference from Rehbein showing the projecting base of a passageway reenforced as a toe to carry pressure of the earth up from underneath.

I think there is no teaching in the Bone patent of anything in the reenforcement of the toe beyond what the ordinary person skilled in reenforced concrete art would have adopted.

Referring to claim 17, it has an inclined heel and a toe with the upright bents, and I have no wall here with the inclined heel and toe. As to the walls in the prior art with the inclined heel and other features of claim 17 excepting the toe, my answer is practically the same as given to claim 3, for this claim with the toe omitted would be the same as claim 3.

The inclination or obliquity has a mechanical advantage to the complete member. In the first place, the oblique member makes a stronger connection for a brace in the heel and the vertical part of the wall. In the second place, you get a greater width for your cantilever beam so that the structure has greater strength to resist the transverse force. A wall with an inclined portion would carry the weight of the retained earth and operate as a reenforced concrete retaining wall and be of better design than one without such inclined portion, because it is made thicker at the weak part of the wall than in the other wall.

The idea of thickening the wall at the weak point was not new with Mr. Bone; that is old. It is brought out in the Bauzeitung publication. The author states very clearly:

"This retaining wall, on which a "Gebrauchsmusterschutz" (utility model patent) has been granted, consists of a vertical and a horizontal member. These two members are rigidly connected with each other. The ratios are so chosen that the resultant of the earth thrust passes through the horizontal part or through the foundation respectively, so that there exists no longer any tendency to
50 tilting so long as the two parts continue to be firmly connected with each other. To increase the stability, the horizontal part is furthermore connected at its rear end by means of anchors with the underground.

"The rigid connection of the two parts may be effected either, as shown in Fig. 25, by continuing the anchors in the masonry or in the concrete of the piles located at the rear, or, as shown in Fig. 28, by enlarging both parts at their joint angle. Of the two methods of construction, the former one, with iron anchors, is to be specially recommended on account of its greater safety."

I think that broadly considered, the only new thing (in the Bone patent) is the use of the special form of reenforcing and described in the various claims, particularly claim 6, which reads as follows:

"6. In a retaining-wall, a series of tapering bents embodied in said wall composed of the upright member *e*, base *g* and tie-brace *f* in combination with the masonry substantially as described."

If claims 1, 3, 5, 16 and 17 are construed more broadly than claim 6, the walls in the prior art answer the descriptions in the claims. Not all of them answer all of the claims, but in accordance with my several answers to the questions you put concerning those claims, that is true. I cannot answer the question as to whether or not the differences in the claims over the prior art are important or such as rise to a higher dignity than mere choice of the workman, or the exercise of mere workmanship by those skilled in the art.

I have examined the drawings of the Marion County walls. No. 420 shows the inclined back and horizontal heel, the heel reenforced at the top and the inclined back reenforced by a single rod. This wall is substantially the same as the Planat wall of 1896, with this difference, that the back of the wall is sloped, whereas the Planat wall is vertical and is not reenforced in the front face away from the earth.

In wall No. 408 I am in doubt as to which is the earth side and which is the front side. Assuming that the right-hand side is the earth side, the wall is substantially the same as the wall No. 420, with the exception that there are more longitudinal bars put in there to take up shrinkage. On mechanical principles there is no distinction between them. No. 252 wall has inclined bars between the heel and vertical portion, and longitudinal ribs for shrinkage purposes. This is substantially the same as the Planat 1896 wall, after the inclined brace suggested by Planat has been inserted.

51 Comparing the Marion County wall with the Bone wall, as shown in his patent, we must agree upon some definitions of the terms. Assuming the broad construction of the words "metal structures" and "upright bents," which I think are the incorrect definitions of those words, wall No. 252 has a metal structure em-

bedded in the wall and running obliquely in the heel, but the weight of the retained material does not rest in any physical sense on the heel of the metal structure. Wall No. 252 has no inclined heel and does not correspond to claim 3 in a broad view, while No. 252 corresponds to claim 5 with the exception that the weight of the retained material cannot rest on the physical structure.

As to claim 16, wall No. 252 has a heel and toe along its sides, and the toe has a metal structure independent of the metal structure in the wall, and it continues down along the upper part of the heel to the back part thereof. The weight of the retained material cannot in any physical sense rest on the heel of the metal structure.

If, however, the words "metal structure" and "upright bents" are defined according to my belief, then wall No. 252 corresponds to no one of these claims.

Wall No. 108——

Mr. Lockwood: You may omit that. (Believing that it had been excepted by counsel for plaintiff (p. 5.)

Wall 420 is like wall 252 excepting that there is no inclined base connecting the base with the vertical part of the wall and there is no reenforcement of the toe. Considering the words "metal structure" as broadly construed, it would run obliquely in the heel and it would substantially meet claim 1, but with the other construction given to the term "metal structure," the wall does not meet the claim. Wall 420 does not have any inclined heel and does not meet claim 3. In 420 the metal structure, broadly considered, can hardly be said to continue down the upper part of the heel of the wall in an inclined direction. If a strict construction be given to the words "metal structure" and "upright bents," the wall 420 does not meet the claim. This wall has no independent metal structure in the toe and does not meet claim 16. The metal structure does not continue down along the upper part of the heel, and, therefore, would not meet claim 17.

The Marion County walls, particularly the reenforcing therein, are more nearly like those disclosed in the prior art than that disclosed in the Bone patent.

52 I have compared personally the original publications or books from which the photographs of the portion of the Rehbein publication, which we have here and have been using, and of the Nolthenius publication, and of the two Planat publications with the photographs and find that they are true and correct copies.

I have made a translation of the articles of Planat in "La Construction Moderne."

Mr. Lockwood: The photographic copies of the Rehbein, the Nolthenius and the Planat publications, and a certified copy from the Patent Office of the Bauzeitung article and the official translation of the Patent Office, and a certified copy of the file wrapper and contents of the Stowell and Cunningham patent are offered and admitted in evidence.

Also certified copies of the file wrapper and contents of the Bone

patent in suit and also of a prior application of Mr. Bone, which was abandoned, filed December 5, 1898, No. 698,698, and the models of the Stowell and Cunningham wall, the Rehbein wall, the Nolthenius wall, the Planat wall of 1894, the Planat wall of 1896, the Marion County wall and the Bone wall, and the drawings of said walls used by the witness, Prof. Hatt, in his testimony, including the drawings of the Bauzeitung wall, the Rehbein wall, the Nolthenius wall, the Planat 1894 wall, the Planat 1896 wall and the Bone wall, are offered and admitted in evidence.

Witness Hatt: I have examined the Akron wall which is a part of the record in the Akron v. Bone case in the Sixth Circuit Court of Appeals. The Akron wall differs from the Indianapolis wall in this respect, that the Akron wall has an inclined heel, an inclined toe, and some of the bars continue from the vertical face into the inclined heel, one continuous bar; every fourth bar is continued down and turned from the vertical part into the heel, in the Akron wall. Likewise, in the Marion County wall, the bars appear to be all of the same length in the vertical portion whereas in the Akron wall the bars are of two lengths, one being of the height, another two-thirds and the third bar a little less than one-half the height of the wall. The Akron wall has a bar in the bottom of the toe, whereas the Marion County walls 420 and 408 have no such bar. The Akron wall has longitudinal bars in the face, but no vertical bars there as far as I can gather from the drawing, while the Marion County wall has such. The Marion County wall has longitudinal bars in 408 and none in 420. The Akron wall has longi-
53 tudinal bars only in the face. The Akron wall seems to be of two types, two styles of construction. On a portion the cantilever bracing is continues; on a portion that cantilever bracing is concentrated at the so-called counterforts.

W. K. HATT:

On cross examination, the witness defined the distinctions between cantilever and counterfort types of retaining walls as follows:

"In the so-called cantilever wall the bracing between the vertical portion and the horizontal heel, or inclined heel occurs all along its section distributed throughout its entire length. In the so-called counterfort wall that bracing action is concentrated at certain sections, and the load which acts between those sections is carried longitudinally, travels longitudinally to the braces where it is taken up, just as in Mr. Bone's wall he has an I-beam in the heel which he says carries the load to the braces. That acts then on the counterfort principle; the only difference in mechanical principle between the so-called types lies in that in the cantilever the bracing bars are distributed longitudinally and in the other horizontal bars run to counterforts. Now these counterforts may be of several kinds. They may partly emerge from the wall, or they may fully emerge and become as the bars shown here; or indeed, they may be conceived of as being concealed in the wall. That is the only distinction between the two styles of wall in their mechanical action.

If I would attempt to define the type of the Bone wall of the patent

I would have to use a term in common use and call it a bastard wall. It is not true to any type. It is partly counterfort action and partly cantilever action.

In the Counterfort wall there must be reenforcing running in the horizontal direction. Before we had the days of concrete walls, in stone masonry the counterforts were simply thickenings of the wall or buttresses and these words were used interchangeably. Now we have taken it over into reenforced concrete and called them mostly counterforts. These are reenforced in several ways."

In the slab of a counterfort it would be necessary to place horizontal bars and they would be positioned away from the earth in the center of the distance between counterforts. Now, it might be in a scientific design, such as is used sometimes by those skilled in the art, that those rods would turn from the outside face to the
54 inside face where they pass the braces. It would be a continuous slab. Between the counterforts the action of the heel or its rearwardly extended slope on which the earth rests is that of a beam and obviously the bars should be in the bottom of this heel running longitudinally toward the concentrated brace, and in a skilled design, they should pass to the top of the heel when they went by the braces and these rods would run at right angles to the ribs paralled to the wall proper.

In designing a wall of the cantilever type, it is necessary to place the reenforcing in the vertical wall, near the earth, in the earth side of the wall and such reenforcing would be vertical. The heel of a cantilever wall is reenforced with rods running transversely to the length of the wall and in the upper part of the heel.

The Planat wall of 1894 is of the so-called concentrated brace type bars running longitudinally in the wall and bearing on this concentrated brace. I would suppose that that would, in general, follow the mechanical counterfort type. The broken red lines in the drawing of the vertical wall and in the heel, are longitudinal rods running in the base and the vertical part of the wall, away from the earth, for beam carrying action, constituting a concentrated brace wall. That part of it is in accordance with the design of the counterfort or concentrated brace wall. I would put bars of that sort for shrinkage in a cantilever wall, but not for mechanical action; they would have no reference to the principle on which the wall operates by maintaining its load.

On page 611 of the 1894 article, about the middle of the page, is the French expression "les barreaux de la nervure," which is "the bars of the rib." To explain how, from that expression, I have been able to place these bars in the rib, as I have done in that drawing, we will have to go back from that to the art of reenforced concrete as it existed in that day. That word "nervure" in reenforced concrete refers to a vertical rib from the floor, which corresponds to the floor beam in the ceiling of a building. The slab runs between the ribs so the ribs are vertical, and these bars run in the bottom or tension side of the rib. Now, Mr. Planat shows how to design a cantilever wall, and he shows how to change the cantilever wall into a wall "à la nervure." He concentrates the bars at the "nervure." That

nervure occupies the same relation to the slab as a floor beam does to the floor in an ordinary building, and reenforces in the same way. The author also shows in Fig. 1 the line or location of that reenforcing. I would say that the article is entirely clear as to where the bars should be placed, and especially it is reenforced by the article of the author of 1896. The internal evidences are in this article and can be reenforced by reference to another earlier article in the book.

The evidence in the citation of 1894 enables me without any doubt or hesitation to place the bars as I have shown you, and further evidence can be found in the preceding article where he refers the same form of construction.

These ribs operate as cantilever ribs fixed at this point (indicating). These also when fixed at this point operate as cantilever ribs. These nervures are for the purpose of taking care of the transverse forces—one of them the pressure of the earth on the vertical portion of the wall and the other the weight of the earth on the horizontal portion. It is not wholly true that these nervures are for the purpose of taking up the stresses in this longitudinal reenforcing in the slabs of the wall. They do that and also take care of the transverse stresses. The reenforcing between the ribs is that of the counterfort wall. I consider that to be the practical wall, if you mean that it would set in place and operate and give satisfaction. There is no question about that.

I think that these bars in the ribs would be amply sufficient without any anchorage other than they had to take the stresses transmitted from them by the ribs to the wall and still remain embedded in the concrete, but I do not think it would have a very great factor of safety. It would be better to anchor them in any way.

Hyatt in his publication of 1877 shows a clear mechanical conception of reenforced concrete. I do not consider however, that the principles of reenforced concrete were fully understood at that time: we do not fully understand it now.

Pages 77-81 of the Akron record discloses the Lehmann-Möller Danish patent of August 13, 1900 which is a cantilever retaining wall operating on the cantilever principle.

The Stowell and Cunningham wall is a kind of counterfort type. I do not think that the Stowell and Cunningham patent shows a clear understanding of the art of reenforced concrete. I cannot state whether their wall is such a one as an engineer would design at the present day. I would have to know the circumstances under which the engineer works.

Redirect examination of W. K. Hatt:

I think the vertical members in the Planat 1894 construction represent substantially the same thing located at intervals in the wall, transmitting stress from the bottom to the top. Bone has a stiff joint at those intersections. That is the only difference.

In the article about the 1894 wall, Planat refers in several places to the cantilever span; and also in the article about the 1896 wall,

The definition of the word "nervure" in the technical dictionary in six languages I find to be "a rib."

Mr. Lockwood: The deposition of Prof. Vos, of Indiana University, giving a translation of the Tijdschrift or Nolthenius article, or the portion about which this witness testified, and also the Rehbein article and the photographs of the portions of said books which Prof. Vos translated, are admitted and read in evidence.

Rebuttal Evidence.

Testimony of Daniel B. Luten.

DANIEL B. LUTEN, a witness called on behalf of the complainant in rebuttal, testified:

I am forty-six years of age; residence, Indianapolis; occupation, civil engineer.

I was graduated from the University of Michigan in 1894, Department of Civil Engineering, and taught one year in that department; I taught for four years at Purdue University in the department of Civil Engineering, and since that time for sixteen years I have been engaged exclusively in the designing and supervision of construction of bridges, the total number of which erected under my supervision approximates eight thousand, mostly bridges with wings and retaining walls. I have filed applications for eighty patents in the United States, mostly on reenforced concrete construction, and am familiar with all of the references cited in those applications. I have testified in approximately twenty-five suits for infringement of patents.

I have heard the testimony given here and have examined the various references cited and introduced in evidence and understand same.

57 The Rehbein publication was a catalog issued by the firm of Wayss & Company showing Monier constructions. It bears the date of 1894 and shows on plate 8, previously referred to in this case, a section of a culvert together with a wing wall. The broken line in the rear of the wall in the Rehbein publication indicated by the right-hand figure at the bottom of the page, refers to the buttress or counterfort for supporting the wall. The wall is a counterfort wall supported on a concrete base represented by the shaded portion below. There is only the fine line to show the reenforcement, but my understanding is that it has a network of the Monier type, consisting of rods in transverse directions with meshes of possibly two or three inches. Figures 25 and 26 of the Bauzeitung article illustrated a counterfort wall anchored at the rear. Figure 28 at the right-hand side of that page of the Bauzeitung article is a wall of plain mortar only and seven feet in height. For that small height, it would carry some load, small load. It would hardly be considered practical at this date because it depends only upon the strength of the mortar for retaining its position. I did not find any teaching in that disclosure which would indicate a reenforced concrete cantilever type of wall. I did not find in the figure nor in the

article concerning the wall of the Planat printed publication of 1896, the construction of the Bone claims 1, 2, 3, 5, 16 or 17. The Planat 1896 wall does not have the reenforcing structure obliquely in the heel nor in the toe.

By extending the base forward, under the vertical stem of the wall, a corresponding amount can not only be removed from the heel of the wall, but an even greater amount with equal stability, and this in face of the rather surprising feature that adding weight upon the heel would seem to increase stability. In short, removing a part of the weight at the back of the wall and placing it in front actually results in saving of material in the base.

I would consider the sketch of the Planat publication of 1894 to indicate a counterfort wall because the wall has counterforts or buttresses at the rear. The reenforcement, however, is not placed as it should be placed properly for a counterfort wall and I doubt if the wall would be operated except for very small size.

The Court: Going back to the question he answered, you do not claim you are the first people to put a toe on, do you?

Mr. Ewald: An operative toe.

The Court: It does not occur to me that you can get
58 through on a proposition that to my mind is perfectly obvious. It is foreshadowed, anticipated, shown a number of times. It is a mere matter of mathematics or experience, as a matter of fact, but there is no invention in that.

Mr. Ewald: If your Honor please, we maintain that not only are the claims drawn to include the toe, but call for a reenforced toe in combination.

The Court: I am speaking of the feature about which the witness testified a while ago, as though this man was to have the credit for this invention because, forsooth, he was the first man that conceived the idea of putting the toe on, and thus not only reducing the size of the heel but the whole foot. I do not understand that you people were the first to put on the toe, and so far as the mechanical advantages of the toe are concerned, if it is true that you put the whole foot there, heel and toe, and that the whole foot requires less material than the heel, then there is no invention in that.

Mr. Ewald: If your Honor please, we maintain that the evidence we will put on in rebuttal, and by Mr. Bone himself, will show that Mr. Bone was the first one to put up a wall of cantilever construction, and since that time there have been hundreds and thousands of walls put up of the cantilever type.

The Court: So far as the questions in this case are concerned, it strikes me that it is immaterial to go into all this description about the cantilever type and the counterfort type. Here is a man that comes along and claims to have taught the art for the first time how to build a reenforced concrete retaining wall. How did he do it? Did he invent it? I don't care whether you call it cantilever or counterfort, or whether the one more nearly approaches the other, or is a bastard or hermaphrodite or combines both of them. It don't make any difference. What did this man do? In view of the prior art, what did he do? The Circuit Court of Appeals for the Sixth

Circuit pertinently says: "If the prior art had shown a structure intended for a retaining wall, and having a heel such that the weight of the earth thereon would tend to keep the wall erect, it might be difficult to find invention in merely adding the form of reenforcement," and so forth. Now, the prior art does show that, as we know from the evidence in this case.

Mr. Ewald: Not a practical wall.

The Court: Well, the prior art shows it. You cannot predicate invention on size, or proportion or weight.

59 Mr. Ewald: The invention, if your Honor please, is in the principle of operation of this retaining wall, and you will find in the Akron record walls that are retained by the weight of the material on the heel; that is not new; but a wall of reenforced concrete, cantilever type, is new.

The Court: Which is? The reenforced retaining wall is new?

Mr. Ewald: Of cantilever type.

The Court: That does not cut any figure here to my mind. I think under this evidence you will have to go further. I understood you to state that he is the first man to make a reenforced concrete wall. When it comes to reenforcement, that is old. He is not the first man to have a reenforced retaining wall. He is not the first man to put a retaining wall in. I understood you to say this morning he combined there elements for the first time. Is that true? There is no interaction between the reenforcement and the pressure of the earth. They work together in a sense, but they do not coact in a sense that is necessary to make a combination. But up to this time you have started out by attempting to prove to me that the several elements are new, when it is perfectly apparent that they are old. *Wherein* does the invention consist. That is what I want to know.

In the combination of a base with an upright wall so secured to that base that the weight of material upon the rear enables the wall to be self-supporting; but with the reenforcement placed in the wall itself, and not in buttresses behind the wall.

The Court: Well, do you concede that this represents the Stowell and Cunningham? (referring to a model.)

Mr. Ewald: That is a fair representation of it.

The Court: I do not see where you advanced over that.

The Witness: The Stowell and Cunningham patent, as shown in that model, represents a vertical wall and a base with guys from the top of the wall to the rear of the base at occasional intervals. These guys are embedded in counterforts merely to protect them against rust. I call them guys merely to show their function in this particular case; the patentee has embedded a complete metal retaining wall in concrete merely to preserve the metal.

The Court: It does not make any difference what his purpose was. There is a retaining wall with a heel, a base with a metal frame, a metal structure embedded in the concrete, and the earth
60 rests upon the heel or the base, and by that pressure keeps the wall from pressing out. That is exactly what your man does. He does it with a framework embedded in that concrete.

Mr. Ewald: But in our case the framework is an entirely different construction.

The Court: How different?

Mr. Ewald: In the Bone patent this base has been inclined and reinforcing members placed along the back.

The Court: Let us change the shape of it. Take a base that is six inches in diameter at the bottom and four at the top. I change it and make it twelve at the bottom and five at the top. Is there any invention in that?

The Witness: The sizes of these members have not been changed in the Stowell and Cunningham patent. The form and shape of the structure embodied in the patent has.

The Court: Then the invention rests on the form of construction?

The Witness: No, on the form shown in the Bone disclosure.

The Court: If that is a fair representation of the Stowell and Cunningham patent, it discloses an upright retaining wall with a base, a heel sticking out on the inside for the earth to rest upon, to sustain the pressure against the wall here (indicating) with a metallic structure embedded in the concrete. That is exactly what that is. That is what it represents. There it is.

Mr. Luten: But the structure of the Bone claims can be set up and will hold in place; it makes with the concrete a self-sustaining structure. That is not true in this structure at all.

The Court: That may well be. The question is whether that is equal to this (indicating). It occurs to me that a skilled mechanic having seen the disclosure of the Stowell and Cunningham patent could have made this. He would have to be skilled, however. He would have to understand the art. But what is there that discloses invention?

Mr. Ewald: In that wall the entire cycle of operations—the entire cycle of stresses is absolutely reversed from those in this wall.

The Court: How? Explain that to me.

Mr. Ewald: In this wall the stresses are transmitted by this longitudinally and horizontally along from this vertical slab, and these operate as buttresses.

The Court: That is the counterfort type, isn't it?

61 Mr. Ewald: This is the counterfort type, and that is the cantilever type of wall. If your Honor cannot see the distinction between cantilever and counterfort walls—

The Court (interrupting): I see the distinction, but it has nothing to do with the case.

Mr. Ewald: Well it is that distinction upon which our contention rests.

The Court: This opinion of the Court of Appeals says that if a certain state of facts existed, it would be difficult to show invention. "If the prior art had shown a structure intended for a retaining wall, and having a heel such that the weight of the earth thereon would tend to keep the wall erect," it might be difficult to show invention. Well, the prior art shows that. There is no question about the prior art showing that, is there? Did you hear my statement?

Mr. Ewald: Yes, I heard, your Honor.

The Court: Now the prior art does show that, doesn't it? "It might be difficult to find invention in merely adding the form of reenforcement most suitable to create the desired tensile strength but we find no such earlier structures—that is, no earlier retaining wall, or structure intended for a retaining wall and having a heel such that the weight of the earth thereon would tend to keep the wall erect. They have produced a half dozen of them haven't they?

Mr. Ewald: There has never been a wall made before the Bone wall where the stresses were carried directly into the vertical part——

The Court (interrupting): I say they have shown here in this case, the defendants in this court room have shown structures, several of them, intended for retaining walls and having heels such that the weight of the earth thereon would tend to keep the wall erect, haven't they?

Mr. Ewald: They have.

The Court: Here is the position you are in. You have either got to take the ground that the Circuit Court of Appeals for the Sixth Circuit took, namely, that the prior art did not show a retaining wall having a heel such that the weight of the earth would tend to keep the wall erect, which you cannot take, or, you have got to take the ground that the prior art does show that. Now, if you concede that the prior art does show that, and I think you must, then you must take the ground that your invention consists of the particular form of the reenforcement; and, if you take that ground, then there is no infringement.

62 Cross-examination of Mr. Luten:

I applied for about 80 patents on reenforced concrete and have about 12 patents. I have litigation going on in various places in the country on my reenforced concrete bridges and structures.

I think there was no complaint in Congress about the grant to me of an unreasonable number of patents on reenforced concrete. I brought suit against the State Engineer of Kansas and he induced his Senator to bring a resolution before the Senate to investigate the issue of patents to Daniel B. Luten. That resolution was passed in March, 1915. In November, 1915, the committee began an investigation and called for witnesses and my attorney and myself were the only ones to appear. Since that time I have been endeavoring to get the investigation started, and have been unable to do so. I am anxious to have the investigation made thoroughly. I have nothing whatever to fear from the investigation of my applications. I am most assuredly interested in the court's sustaining the validity of my patents on reenforced concrete.

Testimony of Frank A. Bone.

FRANK A. BONE (Recalled):

Frank A. Bone testified as follows: At the time I made this invention I was agent for a bridge company, traveling all over Ohio and

part of Indiana and Kentucky, and I at once tried to introduce
e use of it, and in 1898 I made my first proposition to the County
f Butler, at Hamilton, Ohio, a $25,000 job, where I saved them a
rge amount of money, that is, I bid lower but I did not get the
rk. I issued a lot of circulars and described the benefits and
conomies and sent them to every person I thought would be inter-
sted in the subject, and bid on numerous works over the state, but
id not succeed for over three years in getting my walls introduced.
The first wall was introduced at Black Lick, Ohio, where I bid at no
ofit for the contractor, and that work is published in Mr. Ketchum's
ok. It is the first wall, I think, built in the United States, and my
pponents have never found any before it or I suppose they would
ve told me about it. There have been miles of cantilever type
lls made, I suppose, since I got my patent. I have been paid over
fty thousand dollars on royalties for work that was done under the
tent.

Cross-examination of Frank A. Bone:

I have been putting in claims for small amounts for infringement
f my patent and I have been collecting the same, no so much from
unties, as from cities and municipalities. They often settle with,
e rather than go to the expense of suit. I think I have brought
me fifteen suits that have been settled, and they have settled with-
t suits too.

I printed a circular giving the decision of the Sixth Circuit Court
f Appeals, in the Akron case, and have a copy of it.

Mr. Lockwood: Said document is admitted and read in evidence
nd marked "Defendant's Exhibit, Circular About the Akron Wall."

The Witness: I would like to state with regard to that drawing,
hat it showed that wall was one hundred and forty-five feet long,
t had just two counterforts. There were only two in a wall one
undred and forty-five feet long and they were just added, but they
id nothing to do with that suit. I have represented to the public
hrough that circular that that is the Akron wall. You will find
y looking at your blue print there are two counterforts in it.

Q. Some years after the issue of your patent you circularized the
ublic, did you not, that walls with separate reenforcing bars, not
ecured together by metal into a frame, was the Bone patent?

A. I don't know as to that.

Q. You had it in the Akron record, did you not, presenting a
all with separate bars and claiming that to be the Bone patent wall?

A. Well, I don't know. I think after I brought the suit and it
ent on——

Q. But since the adoption by the public of separate reenforcing
ars, you have claimed that those walls were the Bone patent walls
nd circularized the public to that effect, have you not?

A. I do not know as I understand exactly what you mean. I just
xactly put out the kind of walls I made.

Q. You did not put out the kind of walls you show in your patent
fter the first four or five years?

A. I think all cantilever walls are like my patent. That is what I think.

I claim now, and always have claimed, that a wall of cantilever type is an infringement of my patent whether the metal structure is identical with that shown in the patent, or whether composed of bars as in the Marion County case, but, of course, the
64 claims are according to the claims of the patent. They are oblique reenforcing exactly as claimed. I couldn't make but one drawing in the patent. I made one that would be most economical for different places.

Recross-examination of Frank A. Bone.

The first wall I built, the Black Lick wall, was near the arrangement shown in the patent; not exactly like it by a long shot. After the Corrugated Bar Company got to putting out corrugated bars for reenforcing, and they came in general use, I claimed that those walls were the Bone patent walls.

Testimony of Daniel B. Luten.

Witness LUTEN, recalled, testified:

The elements set out in claims 1, 3, 5, 16 and 17 of the Bone patent represent true combinations for the reason that if any of the elements is removed, it affects every other element in the structure. For example, if the inclined bar in the heel is removed, it no longer is in tension, nor is the upright bar in the wall; consequently, each of these bars is affected by the other. Similarly, if the toe is removed, the heel must be extended. Every part of that combination affects every other part as called for by the claims. It is distinctly different from an aggregation, as evidenced by a lead pencil which illustrates an aggregation because the point and the rubber tip will each perform the same function when removed exactly as they do when the pencil has a rubber tip and a point. No such statement can be applied to the Bone wall.

Further cross-examination of Mr. Luten:

The reenforcement in the toe is to prevent the toe from breaking away from the base, from the heel, and it should be placed near the lower edge, as shown in the patent, whereas in the model it is placed at a higher point. The model does not correctly represent that feature of the patent. I think the Rehbein wall is shown as built upon a concrete foundation. If the other illustrations in the book were produced, I believe I could demonstrate that. My understanding of the material shown there is that it is a weak concrete mixture of gravel. The German word "Kiess" is gravel.

65 *Testimony of Evan P. Bone.*

EVAN P. BONE, a witness in rebuttal for the complainant, testified:

I am thirty-two years of age; residence, Cincinnati, Ohio; occupation, Civil Engineer. I am a graduate of the College of Engineering in the Ohio State University; I was associated with Mr. Frank A.

Bone when he was developing the theories of reenforced concrete and developing this kind of construction which were not allied to previous constructions in use. I have written several technical articles, which appeared in the Engineering News and Engineering Contracting. I have been employed for about eight years by the United States Government in the designing and construction of locks and dams on the Ohio River. I am at present employed by the United States in charge of work that involves very difficult foundation work on both rock and sand for retaining walls and dams.

I am familiar with the claims of the Bone patent. In claim 16 of said patent it mentions: "Said toe having an independent metal structure embedded therein." The reenforced concrete toe permits a form of construction when combined with reenforced concrete retaining walls which before that time had never been made use of. Retaining walls had been built for very many years of the gravity type and there were more failures, probably of retaining walls, than any other engineering structure in that line. The reenforced concrete toe permits some advantages which were not possible with the form of construction used up to the time that the reenforced concrete walls were built. There were ninety to ninety-nine per cent of the failures of retaining walls of the gravity type that were due to the settling of the material under the face of the wall. It was not possible with that form of construction to make a wall to avoid this mode of failure. With the reenforced concrete toe it is possible to distribute the pressure underneath the wall and relieve the unit pressure underneath the extreme limit of the reenforced concrete toe. It is even possible, where there is liable to be settlement to construct a reenforced concrete wall so that the settlement will not cause that wall to overturn. The toe can be constructed in combination with the rest of the wall that when settlement occurs the wall will settle down all together and still keep its vertical position. This is the distinct advantage of the reenforced concrete toe, and had never been made use of in any former construction up to that time, although the retaining wall failure was a very common occurrence. The economy, of course, of the reenforced concrete toe permits the moving of the base forward and decreasing the amount of excavation behind the wall necessary in its construction. Also, by the use of the reenforced concrete toe, the length of the entire footing can be decreased,—the quantity of material can be decreased over that which is necessary when the reenforced concrete toe is not used. In claim 16 the reenforced concrete toe having these advantages is specified.

Cross-examination of Evan P. Bone:

I am 32 years old and am a son of Frank A. Bone.

Testimony of Frank A. Bone.

FRANK A. BONE, recalled, identified a catalog and testified:

It is a pamphlet that I published describing a number of walls of reenforced concrete which I had designed and other walls. It is a

catalog such as I used in my business. I have printed many thousands of them and distributed them over the United States in the conduct of my business in the construction of such walls. The said catalog was offered, admitted and read in evidence and marked by the reporter, "Plaintiff's Exhibit Bone Catalog."

Testimony of W. K. Hatt.

Further direct examination of W. K. Hatt:

The various models and drawings about which I testified and which have been introduced in evidence are substantially correct reproductions of the walls described in the prior art which they purport to represent. I compared the original books in the libraries with the photographic reproductions of the portions of the Tijdschrift publication, and also the Rehlein publication forming a part of Prof. Vos' deposition, and they are correct copies thereof.

Mr. Lockwood: The photographic copies of the two publications referred to, as exhibits, in addition to the offer of the depo-
67-8 sition of Prof. Vos, are offered and admitted in evidence.

The Witness: The reenforcing in the Marion County wall and the Bone wall is not equivalent; that is, the continuous metal structure, or a number of metal structures riveted together or otherwise connected by metal connections so as to be entirely united, is not the equivalent of a number of separate bars not connected, but separate and overlapping, with the ends of the bars projecting into the concrete beyond.

As to the contention about the cantilever and counterfort style that has been mentioned, it is in my view simply a question of the distribution of material to effect economy. And the different forms do not involve any different principles of action excepting in the single feature that in the cantilever style the stress goes at once, whereas in the other it goes to the back and is distributed to these ribs and centers and then distributed. I think it cuts no figure whether it is cantilever or counterfort style.

Cross-examination of W. K. Hatt:

The operation of the cantilever wall is the operation of a cantilever beam. The cantilever beam, if that is all there is to it, is a beam which projects from the support, it is fixed at the support and is free at the other end in contradistinction to the ordinary beam which is supported at both ends. The French term is "porte a faux." In the calculations, simple beams and cantilever beams are based on exactly the same mechanical principles, expressing conditions alike.

Approved:
EWALD & SHERMAN, *Attys. for Plaintiff.*
V. H. LOCKWOOD, *Solicitor for Defendant.*

Dec. 19, 1916.

(Here follows catalogue marked p. 69, memorandum opinion marked p. 111, and diagrams marked pp. 115, 117, 119, 121, 123, 125 & 127.)

THE

BONE

SYSTEM

OF

RETAINING WALL

CONSTRUCTION

The

Concrete-Steel Retaining Wall Co.

STATION D

CINCINNATI, OHIO

Introduction

We have for several years studied the construction and tests of the Bone system of retaining walls, sea, lock and area walls, bridge abutments, etc., and now feel justified in recommending it to the public.

In this system of construction, many stresses overcome in a plain concrete wall by mass of material are by the Bone wall taken by the steel reinforcement. The wall is therefore much thinner and more economical.

A great advantage over plain walls is also obtained in the fact that the earth pressure can be distributed over the foundation to suit the conditions. A broad base, with a uniform pressure, can be obtained, which is impossible in a plain gravity wall.

This company, with engineers who have spent years in this special line of work, is devoting itself to the introduction of this wall.

We ask that you afford us an opportunity to demonstrate the economy and advantages of this system, for we know that you will agree that economy, when not at the expense of quality or stability, is worthy of full consideration. If you have any work of this character, we ask that you advise us. We will promptly prepare plans and estimates and submit them to you. We ask no other favors, as we are confident that the value of our plans and economy of our proposal will meet with your approval.

THE CONCRETE-STEEL RETAINING WALL CO.,
Station D, Cincinnati, Ohio.

New York and Pennsylvania Agency:

THE FERRO CONCRETE CO.,
Calder Building, Harrisburg, Pa.

Reinforced Concrete Construction

Reinforced concrete construction has passed the experimental stage and is now admitted to be, when properly designed and constructed, one of the most reliable and permanent building materials known. This is shown by the wonderful increase in the number of structures built of reinforced concrete during the last few years. Not only of buildings, but also of structures exposed to the roughest elements of nature, such as dams and bridges.

The advent of this material revolutionizes retaining wall construction and makes possible our greatly improved type of wall.

Description

The Bone Retaining Wall is a reinforced concrete structure, so arranged that the weight of the retained material acts as a force to keep the wall in an upright position.

A heel is extended to the rear of the wall. The earth fill rests upon this heel, and the wall can not overturn without lifting the earth above the heel. Thus the weight of the retained material itself keeps the wall in its normal position. The earth on the heel can be considered an integral part of the structure, the materials of construction of which are concrete, steel and earth, the concrete steel part simply serving as a casing to keep the earth part in shape.

A toe can be extended to the front of the wall. This produces a longer leverage, giving the wall a greater resistance to overturning, and also distributes the pressure on the foundation.

The rupture of the wall itself is prevented by the reinforced concrete construction. Sufficient area of steel and concrete are used in the proper places to resist, respectively, tension, compression and shear.

Economy

The economy of a retaining wall which makes use of earth to give it weight in place of concrete is readily seen. There is an old proverb which says something about "as cheap as dirt." This applies literally to our wall. The extra cost of the steel which must be used to reinforce the concrete is small, compared with the gain. The forms for walls of the types shown in Figs. 1, 3 or 4 actually cost less than for a gravity or solid concrete wall of the same height.

C. H. Graff, C. E., of the Great Northern Railway Co. (see Eng. News, March 9, 1905), made a series of calculations as to the saving that can be obtained by using reinforced walls as compared with plain concrete walls of the same stability, with the following results:

For wall 40 ft. high, saving 45 per cent.
For wall 30 ft. high, saving 43.3 per cent.
For wall 20 ft. high, saving 30.4 per cent.
For wall 10 ft. high, saving 20.4 per cent.

We give in this pamphlet several designs comparing the amount of material used in our wall with that used in a plain wall; also, examples of actual bids taken, and refer here to bids received for construction of the abutments and wing walls of the Reed Avenue Viaduct, at Columbus, O., in spring of 1906, in competition with a gravity wall of sandstone and concrete. Both plans were on file, and were of the same height, length and capacity. The bid of Jones Bros. was $51,929.50 for a gravity wall and $32,695 for a reinforced wall, the gravity wall being 58 per cent more than the reinforced. Other bidders made a large difference, Westwater & Casey making 39.5 per cent, F. M. Townsend 30.8 per cent and Strum & Co., 39.5 per cent. The bids for reinforced wall included an item of $3,000 for royalty, so that the bids showed the net economy of the reinforced wall.

There may be those who do not care for expense, and do not care to consider a more economical system. In the case of retaining walls this is an unwise position. Earth thrusts acting against retaining walls are very uncertain and variable, depending upon many conditions. No engineer can calculate or tell what the pressure against a wall is going to be. It may be slight or it may be great, taxing the wall to the point of failure. It is good practice then to put the money and material to the best possible advantage by using the form of construction of the highest efficiency. Good engineering ability and judgment could certainly not do otherwise.

Advantages

A better and more scientific wall can be made of reinforced concrete than is possible with plain concrete or stone masonry.

BROAD BASE. By the use of a broad base and a reinforced heel extending to the front of the wall to distribute the pressure on the foundation bed, the unit pressure can be kept well within the limits of the bearing power of the particular kind of earth on which the wall is built. Such a flexibility of design is not possible with a gravity wall of solid masonry. It is not such a problem in retaining wall construction to obtain sufficient weight for stability as it is to get a suitable foundation bed to sustain this weight. Nearly all of the failures of retaining walls are due to the settlement of the earth under the toe, caused by the excessive pressure at this point. Authorities (See Baker's Treatise on Masonry Construction) state that from 90 per cent to 99 per cent of the failures of retaining walls are caused in this way. In gravity walls it is often necessary to use expensive piling. This expense can usually be dispensed with in a reinforced wall by the use of the extended toe.

SETTLEMENT. Many kinds of earth, which must be used for foundations, will settle some when the load is put upon them. In most structures, as in buildings, this settlement presents no serious difficulty, as it is uniform and lets the structure down evenly. In such cases settlements of several inches or a foot can and have been allowed for. But in gravity retaining walls the greatest pressure, and, consequently, the greatest settlement, being under the toe, the wall is thrown out of plumb, moving the center of gravity further forward, and bringing still more pressure under the toe, causing more settlement, and so on. In the reinforced concrete wall the toe can be so extended as to cause the *resultant* pressure to *strike the base in the middle*. This is an ideal condition, and produces a uniform pressure all along the base, resulting in a uniform settlement. The face of the wall will therefore remain vertical.

THE RESULTANT NOT LIMITED TO THE MIDDLE THIRD. In designing a gravity wall the resultant pressure must be made to strike the base within the middle third to avoid tensile stresses in the back. But in the reinforced wall this tension is provided for by the reinforced heel acting as a cantilever beam, and so the resultant is not limited to the middle third, but may strike out near the end of the toe, when on solid foundation. Gravity walls of solid concrete may be able to resist some tensile stresses in the back, but it is not good practice to depend upon concrete to resist tension. If longitudinal cracks or cracks having longitudinal components should occur in the back wall, its ability to resist tension would be destroyed. If in construction, the concreting was ever stopped long enough between the lay-

of two consecutive courses, a weak joint would result. A gravity wall even if built on a solid rock foundation, can only be considered safe when the resultant strikes within the middle third, while a reinforced concrete wall, on the same foundation, will be absolutely safe in this respect unless the resultant strikes out practically at the toe.

SHRINKAGE. An important advantage of these thin walls is that they need only from one-half to one-fourth as much longitudinal reinforcing metal as ordinary walls of same stability to make them safe against vertical cracks caused by shrinkage or temperature stresses that usually occur in dam concrete walls that are more than 30 or 40 feet long.

ALLOWANCE FOR FREEZING. One of the most disastrous agents to be contended with in ordinary walls is freezing. The earth back of the wall, unless excellently drained, is liable to be saturated with water, which expands upon freezing. The force which this expansion produces is irresistible, and the wall, no matter how substantial, is forced outward slightly. This displacement of the wall may not be noticeable for a time, but after many seasons of frost, each one of which adds its increment to the displacement, the wall will begin to lean or to shear off at the top, and eventually to fail. A reinforced wall of the inverted T type is able to stand, without damage, a pressure due to freezing, without rupture or permanent displacement, because the elasticity of the cantilever beam forming the vertical part of the wall will allow it to give considerably and then return to its original position as soon as the force is removed. The frost breaks the earth up into a very mellow condition, and so it is easily compressed by the beam acting as a huge spring, when thawing takes place.

The frost pressure acts mostly at the top of the wall, and, fortunately practically all of the deflection of the concrete steel wall under this pressure is at the top, the place where the greatest displacement is needed. This is explained by the tapering of the beam and the distribution of the reinforcement. According to the primary design to account for the earth thrust, the quantity of steel is so distributed that the unit stress will be nearly the same at all points up the wall. So the unit elongation on the tension side will be the same at all points. But the neutral axis comes nearer the rods toward the top, making the radius of curvature shorter. Therefore, the curvature is greater at the top, and the horizontal deflection much more than at points a little distance down. Now this is the deflection caused by the earth thrust, but the moment caused by the earth thrust varies as the cube of the distance from the top, while the moment caused by the frost acting at the top varies directly as the distance from the top. So when the wall is under a moment caused by frost the unit stress, and consequently elongation, are much less toward the bottom of the wall, and the difference between the two curvatures at the top and bottom is much greater than it is even when produced by earth thrust. So it may be seen that when frost deflects the wall at the top the displacement will be practically nothing further down on the wall, giving the earth no room to drop down and keep the wall from coming back.

There is no serious objection to the deflection of the wall under earth thrust, as this can be provided for the same as the linear expansion of walls and bridges, due to shrinkage or temperature changes.

ANCHORAGE OF THE MAIN REINFORCEMENT IN A CANTILEVER WALL.

The anchorage of the vertical rods in the base and also the transverse rods of the heel in the vertical part of the wall in an L or T shaped section used in the cantilever type is peculiar, in that the adhesion per square inch is far greater than in ordinary locations, because the region in which the anchorage of these rods are situated is under the greatest compression of any part of the wall. We have tested one half inch square twisted rods placed in like condition with the anchorage ends extending eight inches into the beam (this being the full depth of said beams) and found the adhesion was in no case less than 1,010 pounds and ran as high as 1,303 pounds per square inch and in no case did the rods pull out, the failure occurring by the concrete crushing or shearing, so we have reason to think that in the tests the rods would have parted, leaving the anchorage ends in the concrete had not the concrete failed first, as in one case the rod had reached a stress of 80,980 pounds per square inch.

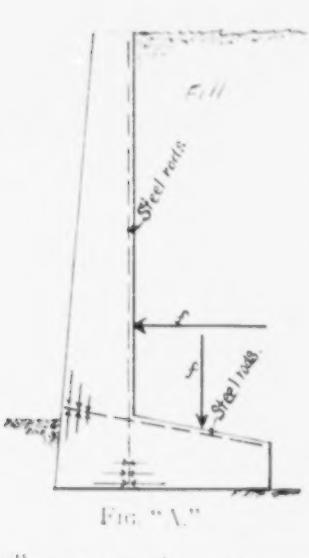


FIG. "A."

Fig. A shows by the large arrows the directions of the external forces which tend to stress the whole wall, while the small arrows show the direction of the internal stresses which clamp the anchorage ends of the rods. It is evident that as the external loads increase the clamping action on the anchorage ends of the rods also increases on the same principle as the ice tongs, the greater the load the greater the vise action.

This security of anchorage for the principal reinforcing members of retaining walls is important.

First: It obviates the necessity of hooks or bends on the ends of the rods. Second: It requires less length of rod. In fact, a shallow depth of beam gives greater vise action. Third: Safety; in case the natural skin adhesion of the rods should be wanting or be destroyed, the vise action would still operate and would amount to as much as the co-efficient of friction multiplied by the pressure exertion on the rods, and would in case of deformed rods amount to enough to give sufficient anchorage has been found to be the case by tests on a model wall.

COMPARISON OF TYPES OF REINFORCED WALLS.

We have confined our illustrations in this catalog almost entirely to walls having what is called the inverted T section and the L section.

Practical work has led us to construct this type in preference to walls having counterforts, although at first view the counterfort wall may appear preferable. We take the space here to give some of the reasons that causes us to favor the cantilever type of wall construction.

First: The calculations for internal stresses in all the different parts of the wall are direct and simple, none being indefinite or indeterminate. In a counterfort wall the principal force that prevents the wall from overturning (viz., the weight of the earth on the heel), must travel lengthwise of the heel to the counterfort; thence diagonally up the counterfort; thence lengthwise of the wall to the point of required application; while in a cantilever wall the stress goes directly from the heel to the vertical part of the wall. The upward reacting force under the toe in a counterfort wall likewise usually has to travel in a roundabout path similar to the force in the heel.

Again, the heel of a cantilever wall has stress in but one direction, while in a counterfort wall it has a downward stress in the back portion and nearly always an upward stress in the portion next to the trunk of the wall, thus requiring two sets of rods, one on the bottom as well as on the top of the heel. The calculations to find where the stress on the bottom set begins or stops is complicated as various loads must be assumed to obtain the maximum limit.

Second: When the internal stresses for a cantilever wall are figured for the maximum load no smaller load will stress any part of the wall as much; while in a counterfort wall some parts are stressed most with a load less than the maximum.

Third: The bending and shearing stresses are maximum at the same point in each member of a cantilever wall and in practice no attention whatever need be paid to the shearing stresses as there is always plenty of material to take up the shear when the tensile and compression stresses are provided for.

Fourth: In a cantilever wall the reinforcing rods in each member act strictly in series and a defect or failure in a rod would be of little importance and would act only to lower the factor of safety a small percentage.

This use of numerous rods in a member all acting together would justify it to be said that the factor of safety is raised as compared with the use of a few rods of equivalent section to resist the same stress. A counterfort wall has a full panel load concentrated at a counterfort and therefore does not admit of such a distribution of rods as mentioned above. The

latter recommendations for good practice advocate the use of small rods and the avoidance of the testing of large rods wherever it is possible.

Fifth—Longitudinal rods placed in the wall to take up shrinkage and temperature stresses are not called on in a cantilever wall to bear any bending or shearing stresses and can therefore be relied on fully for the purpose intended.

Sixth—In a cantilever wall the face or exposed portion of the wall is stressed only in compression when loaded, and an overload does not tend to open out small cracks and disfigure the face as it does in a counterfort wall where the face is always in tension midway between the counterforts when loaded.

Seventh—A cantilever wall of say 12 feet or more in height is able to withstand without damage a temporary irresistible force, such as caused by frost or ice at the top because there is enough elasticity in the cantilever beam forming the vertical part of the wall to allow it to bend considerably under such a force and then return with no injury to its original position as soon as the force is removed, while a gravity or a counterfort wall does not possess this quality except in a very minute degree. This point is considered quite important by most engineers, as many walls fail by being pushed out at the top by freezing. A little one year and a little next and so on till failure occurs. (For detail analysis see "Allowance for Freezing," page 5.)

Eighth—Simplicity of construction.

(a) There is no more work or expense for forms needed than for a plain concrete gravity wall of same height. On this point we would mention that for a certain counterfort wall of moderate height erected in Chicago the forms cost more than the concrete placed in them.

(b) Straight steel rods may be used to reinforce all parts without waste of material and may be placed with much less cost per pound than where hooks or nuts have to be resorted to.

Ninth—The salvage value of the lumber in forms is much greater than in a counterfort wall.

Tenth—On account of comparative simplicity, better workmanship and more accurate placing of the steel is secured.

It is probable a counterfort wall may by using a large amount of steel be made a stable wall with less concrete than a cantilever wall. This is an item to be considered where the materials for concrete are extra expensive.

"Items" 9 and 10 are given in Fourth Report of Illinois Highway Commission as arguments in favor of the use of cantilever walls.

Stability of retaining walls not only depends upon the weight, but also upon the material which sustains this weight. The broad base of our wall decreases the unit pressure on the foundation.

It is an ideal condition in all structures which are subject to settlement to have the resultant pressure cut the base in the middle. This was never possible in retaining walls until the event of the reinforced concrete wall.

Tests of Time

However carefully we may analyze the stresses acting in and against our retaining walls, there is nothing like actual life sized tests.

These have been made, some of which are shown in the accompanying cuts. They have proved the wall to be satisfactory in every way.

Wing wall to Washington Street Bridge, Dayton, O. This is a T type wall. Since the erection of the above wall the city has decided to build an extension of like construction.

Fig. 5.

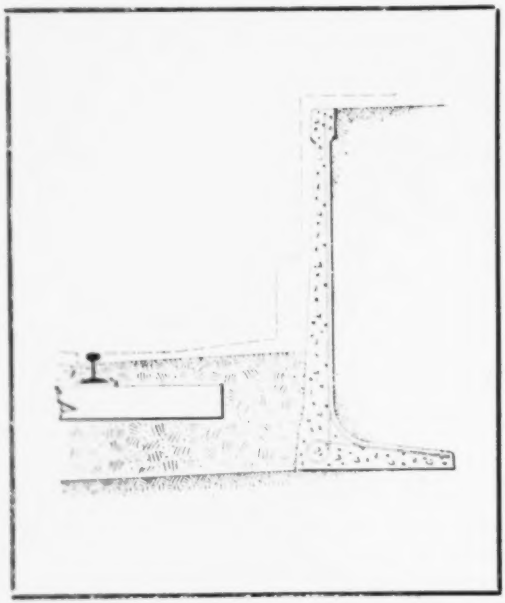
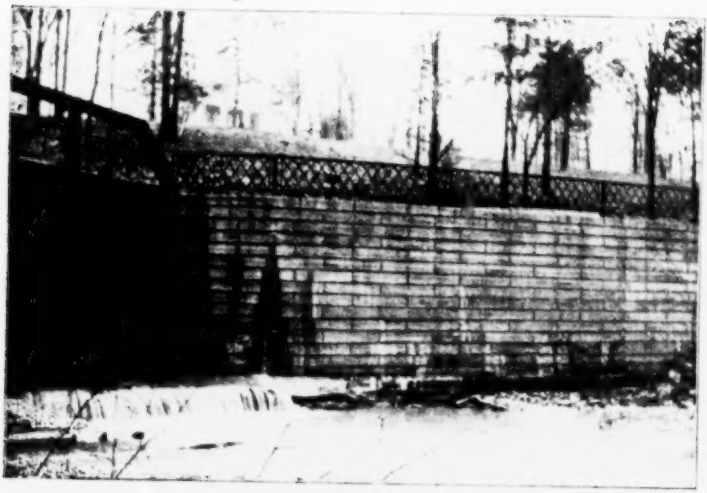


Fig. 6.

Fig. 5 is in the section of a wall, of which 1,300 lineal feet were erected along the Great Miami River during 1906 by the Cincinnati Northern Traction Company.

Fig. 7 gives a design of a low wall to be made in forms and set up afterward.



View of wall at Lebanon, O., taken fourth year after erection.
(The cross section of this wall is shown in Fig. 1 on opposite page.)

Wall erected at Hoffman School lot, Cincinnati, O.

By our wall the earth is made to retain itself. The same force which tends to overturn the wall gives it stability.

The skill of an engineer is not measured so much by his ability to obtain a desired end as it is to secure that end with the least expenditure of material and labor. Any one can, by using an unlimited amount of good material, erect a stable structure, but that is not engineering.

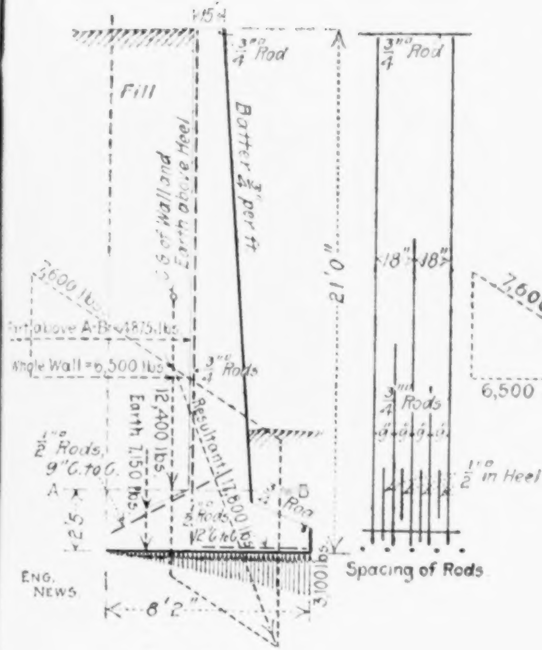


Fig. 1.

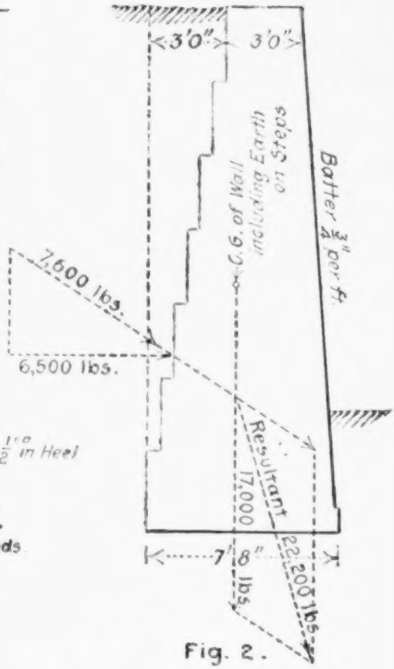


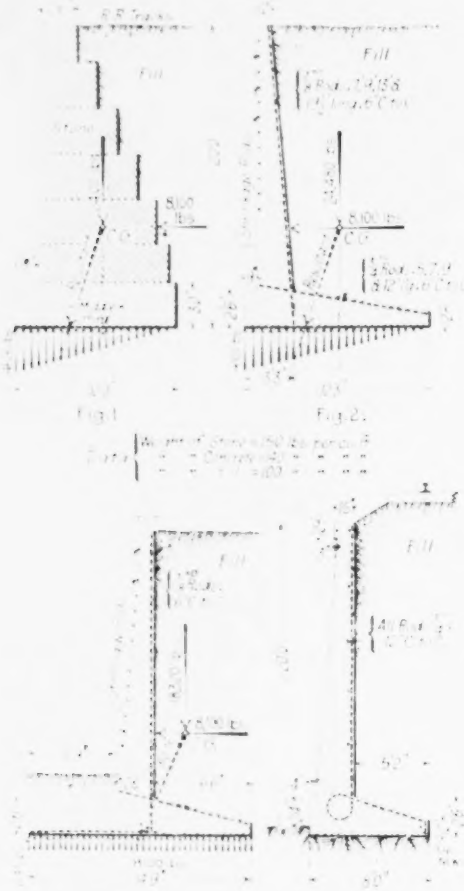
Fig. 2.

Fig. 1 above illustrates a wall built at Lebanon, O. The figure also shows the methods of calculation. The vertical part is figured as a cantilever for the part above A. B. The heel is also figured as a cantilever strong enough to lift the weight of the fill above it, while the toe is a cantilever to sustain the upward reaction of the earth.

Fig. 2 is a gravity wall of same stability as Fig. 1. Both were designed for the same place, and competitive bids were taken on them, with result as shown below.

The County Engineer at Lebanon, O., in a letter written some time after their erection, says of the above walls (Fig. 1): "The walls are altogether satisfactory, and the prices bid on the work at public letting show that walls of same quality, strength and stability of usual shaped section would have cost the county $1,481, or 58 per cent. more than was paid for Bone's walls, including his royalty on same."

A comparison of walls twenty feet high shows that reinforced retaining walls are not only cheaper but are also better than plain gravity walls.



(From *Engineering News*, March 26, 1908, the above cuts and following description is taken.)

Fig. 1 is a section of a heavy gravity used on the Kinsie Street track elevation, Chicago. The extended toe and broad base in the design show an evident desire to distribute the load over a large area of the foundation. The maximum load or outward pressure assumed for the gravity wall causes the resultant to strike just within the limits of the middle third of the base, the resulting stresses under such loading being the greatest allowable under best practice. This load, 8,100 pounds, is over 33% more than Rankin's

formula would give, assuming the material in the fill to take a slope of 33 degrees with the horizontal.

Figs. 2 and 3 are reinforced walls figured for the same loads as that assumed for the gravity wall with a factor of safety of four for internal stresses. As to the stability, Fig. 2 has a larger factor of safety as to tipping forward than the gravity wall, as it brings a 14% less pressure at the extreme point of the toe. It is therefore less liable to settlement at that point. As to resistance to sliding forward on the base, Fig. 2 is fully equal to the gravity wall. Fig. 3 is designed to bring the resultant at the center of the base. This wall under any load not greater than the maximum has no tendency whatever to tip forward as a whole nor to bring more pressure on the toe than at other points and is therefore an ideal design for compressible foundations, as the settlement if any would leave the wall in a vertical position. It is not as stable as to sliding forward on the base as Figs. 1 and 2. Its coefficient of friction, however, is 0.44, which is considered safe on most all foundations, and with the earth or other material in front of the wall as shown it would be amply safe.

Fig. 4 is a section of wall built on rock foundation. A wall 1,300 feet long of the same section as shown in this design was built in 1906 by the Cincinnati Northern Traction Company and has proven entirely satisfactory.

As to the saving of materials accomplished by using the reinforced designs the following comparisons are made with the gravity wall. The stone work and the concrete work are estimated $6.00 per cubic yard, and the steel work at 3 cents per pound. (Straight rods can be placed in the wall at that price with a good profit.)

At the above unit prices the saving effected is:

In design Fig. 2 49.1%.
In design Fig. 3 47%.
In design Fig. 4 61.1%.

In higher walls the percentage of saving is greater.

Actual bids for work show about the same saving as the figures quoted above; for example, at Akron, O., ten bids were received for building a retaining wall running from 31 to 36 feet in height. Each contractor bidding on a concrete gravity design and also on a reinforced design of the same length and height and theoretical stability. The lowest bid, $7,350.85, on the gravity wall, was 63% more than the lowest bid on the reinforced wall, and the average of the ten bids was 43.6% more for the gravity wall than for the reinforced wall.

Most retaining wall failures (Prof. Baker says over 90%) are caused by the settlement of the foundation at the toe, thus allowing the wall to lean forward. We find in the above designs that the pressure at the toe on the foundation in the gravity wall, Fig. 1, is 15.6% more than Fig. 2 and nearly four times as much as Fig. 3.

The reinforced designs are therefore not only cheaper but also far better than the gravity design at the point where failure is most likely to occur.

Fig. 11.

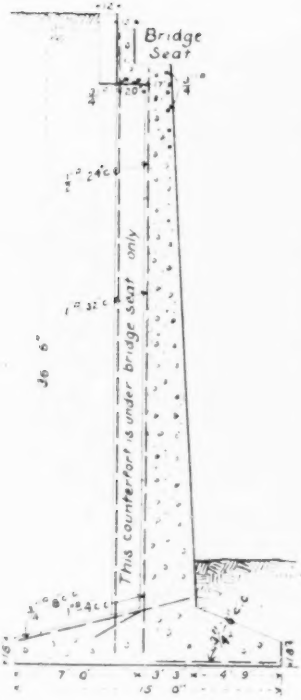


Fig. 12.

Fig. 11 shows section of wall erected at Black Lick, O., in 1900.

Fig. 12 shows section at center of abutment erected at King's Mills, O., in 1905. It supports the end of a bridge span 300 feet long.

The bridge resting on the above abutments was washed off by flood of 1913, but the abutments remain intact. The heavy stone abutments of bridge over same stream, one half mile below, were so badly damaged by same flood, that several thousand dollars were spent to bring them up to original level. Thus showing the superiority of reinforced concrete as compared with stone masonry.

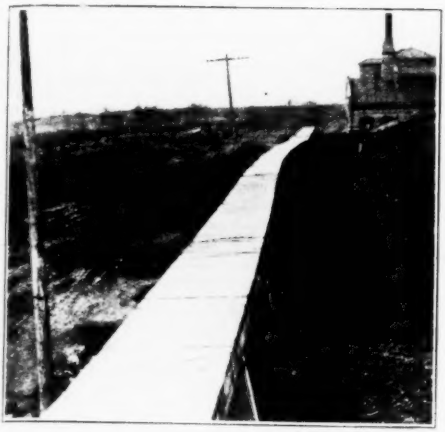


Fig. 8.

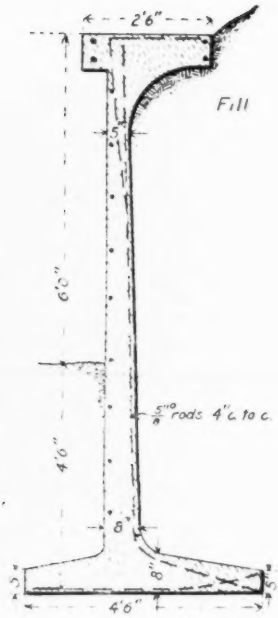


Fig. 9.

The above photograph, Fig. 8, shows a counterfort wall erected on the west side of the New Hospital grounds, Cincinnati, O., while Fig. 9 shows the section of a cantilever wall erected at the same time on the south side of same grounds. The cantilever wall is, after six years' standing, plumb, in perfect condition, while the counterfort is in the condition shown at the left with numerous unsightly cracks in the surface.

As both of these walls were designed by the same engineers and were erected by one (experienced) contractor; the fact that the cantilever stood the test indicates that it is the most reliable type.

Attention is also drawn to the extreme thinness of the cantilever wall.

Fig. 5.

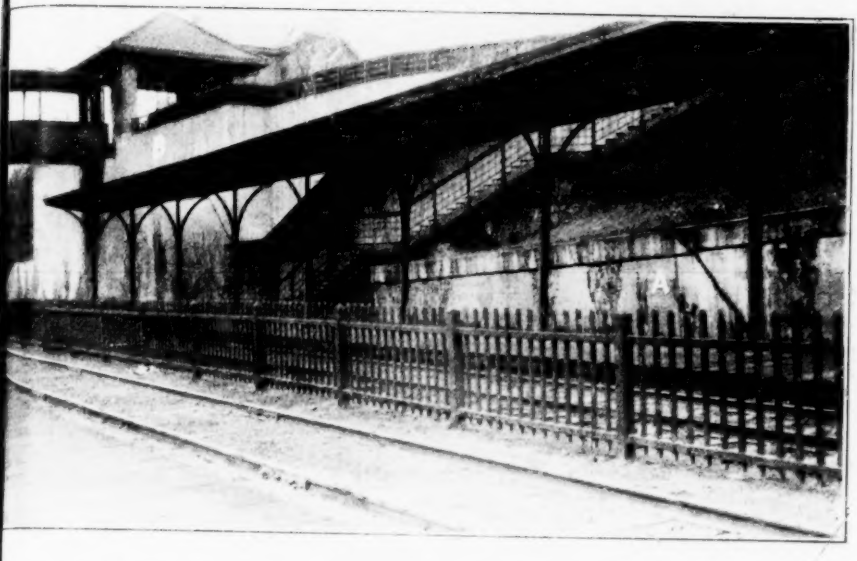
Fig. 6.

Fig. 5 is section of wall erected at Hamilton, O., by the Elks' Lodge.

Fig. 6 is section of wall erected by the School Board of Cincinnati, O.

This wall was designed to rest on a firm clay foundation and where s placed is after four years' service true and plumb. A short portion, how ever, was placed on a fill, not fully settled. This portion of the wall no leans forward considerable, thus showing the need of an extended toe in yielding foundation.

Section of Retaining Wall, Metropolitan Street Railway Company, Kansas City, Mo.



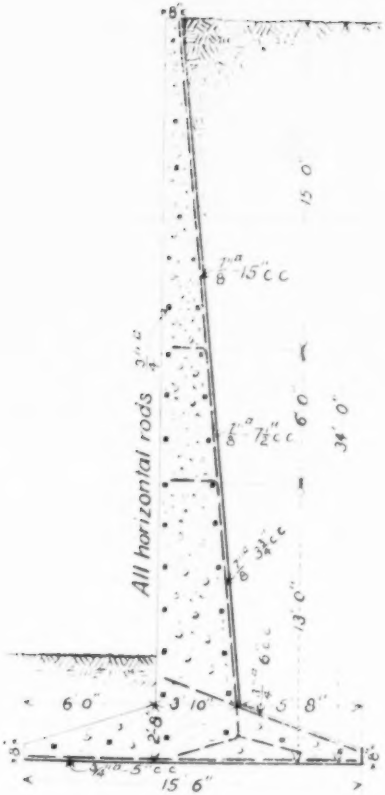
Retaining Walls erected by Pennsylvania Railroad Company at Torrence Road, Cincinnati, O., 1906.

Wall B is a reinforced concrete wall built according to Bone's patent. It is 26 feet high above ground in front and 8 inches thick at top. (See details on page 18.)

Wall A is a heavy concrete gravity wall, 6 to 7 feet high above ground and 28 inches thick at top.

These two walls being so close together are subject to like conditions. The photograph, taken after 7 years, shows B in perfect condition, while A has developed a crack 5 inches wide and leans outward at the top 10 inches, and no doubt will finally topple over.

These two walls were intended to be of like stability. The results surely indicate that B is the most reliable kind as well as the cheapest.



Wall erected by the Pennsylvania Railroad Company at Torrence Road Station, Cincinnati, O. The bank behind the wall is joint clay, and when wet takes quite a flat angle of repose, thus bringing an uncommonly heavy load on the wall.

Fig. 9.

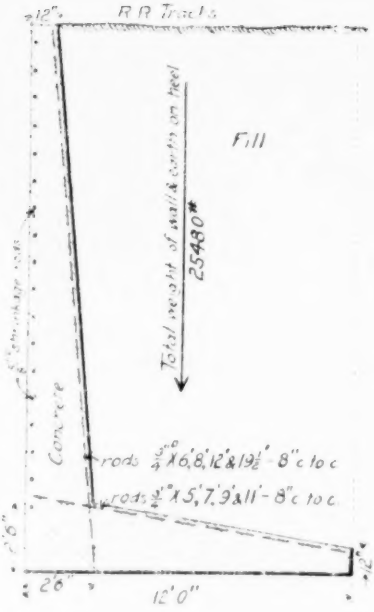


Fig. 10.

Fig. 9 is a section of a heavy gravity wall, used on Kinzie street track elevation, Chicago.

Fig. 10 is section of reinforced wall of equivalent stability as to overturning or sliding on base, and has a factor of 6 for internal stresses, and also shrinkage rods in addition. The wall would overturn long before rupture would occur. This reinforced wall was designed for a location on property line, therefore the toe had to be omitted. If a toe could have been used the design could have been made still more economical. The difference in cost of the two walls would be practically as follows per lineal foot:

Stone wall, masonry, 5.01 cubic yards, at $6.00		$30.06
Reinforced wall, masonry, 1.98 cubic yard, at $6.00	$13.07	
Reinforced wall, extra excavation .12 cub yard, at $0.60	.07	
Reinforced wall, extra fill, 1.9 cubic yard, at $0.30	.57	
Reinforced wall, extra steel, 77 pounds, at $0.03	2.31	$16.02
Difference in cost		$14.58

The above unit prices result in the stone wall costing 91 per cent more than the reinforced wall.

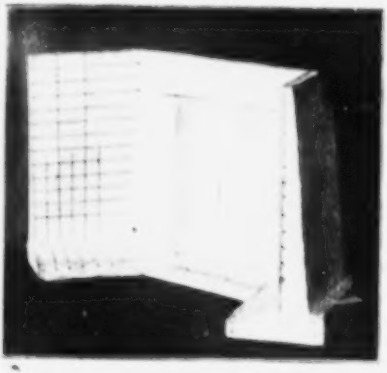
Front view of walls built by Pennsylvania Railroad Company, at Torrence Road, Cincinnati, O., during construction.

The high wall shown at right is used in the wing walls of the west abutment of the Q street bridge in Washington, D. C., and was designed by the Government engineers of that district.

Wall 53 ft. 10 in. high.

Don't turn down a good thing because it is patented. It has been well said, "A farmer who would cut grass with a scythe because the mowing machine is patented would have to eat grass to live."

End of Torrence Road wall before fill was made.

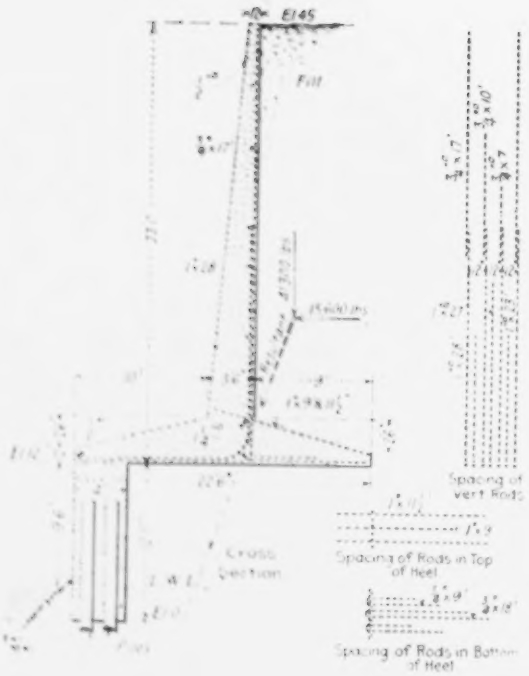


Model of bridge abutment (back view). In this design the reinforcing rods are run longitudinally throughout the walls, as well as vertically and transversely. This makes the whole wall a monolith, free from liability to crack. The two wings and the face wall each assist effectively in maintaining the others in their normal position. Under the bridge seats the wall is made as thick as usual. A large saving is effected in this type of wall, and a better abutment obtained than is usually constructed. Such work as this has been erected in Adams, Shelby, Paulding, Montgomery, Butler, Scioto and Warren Counties, Ohio, and other places.

Wall erected in Marion County, Ind.

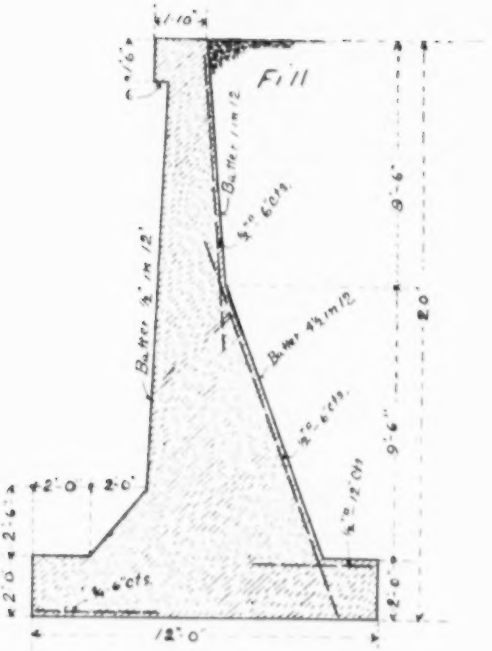
NATURE'S MECHANICS

The shape of an inverted T in a reinforced wall follows closely the adapted by nature in bracing the mighty oaks of the forest. The heel and toe are the brace roots. Nature's principles are always correct and efficient



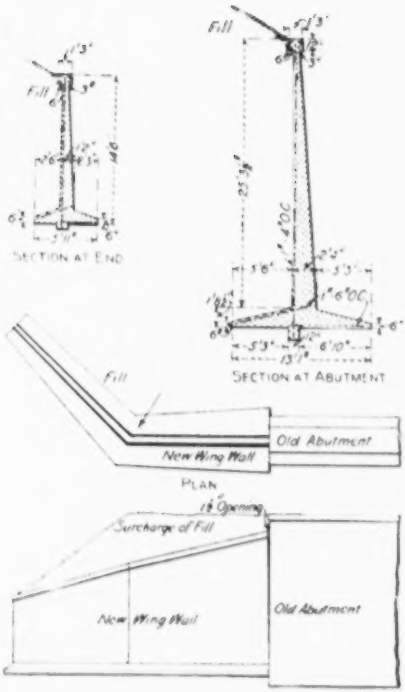
The above wall was erected at low water line of Ohio river in [illegible] on piles and filled ground. After the fill had been completed to the top and the river had risen high enough to saturate the fill the wall settled some back of the piling. This had been anticipated and the bottom of the wide base was thoroughly reinforced so the wall, instead of failing by breaking the toe off or sliding forward, the top of the wall was pressed back against the fill a few inches, which was a most remarkable and safe way for a retaining wall to change its position.

Great economy is secured by this form of wall on account of the small amount of work below water level. The Ohio at this point often fails to get as low as shown during the working season and then likely for only a short time. After the dam which is now under construction at Henderson is completed the piles will always be under water.



Several miles of wall like the above are being used by the C., B. & Q. R. R., Chicago, Ill., and is giving splendid satisfaction. This wall would have been at least 10 per cent more economical if more steel had been used in the back part of the vertical portion of the wall and less concrete. It is what is sometimes called a semi-reinforced wall. The concrete in the vertical portion being stressed in compression but a fraction of its safe capacity. The concrete in the toe, however, is subjected to higher stresses.

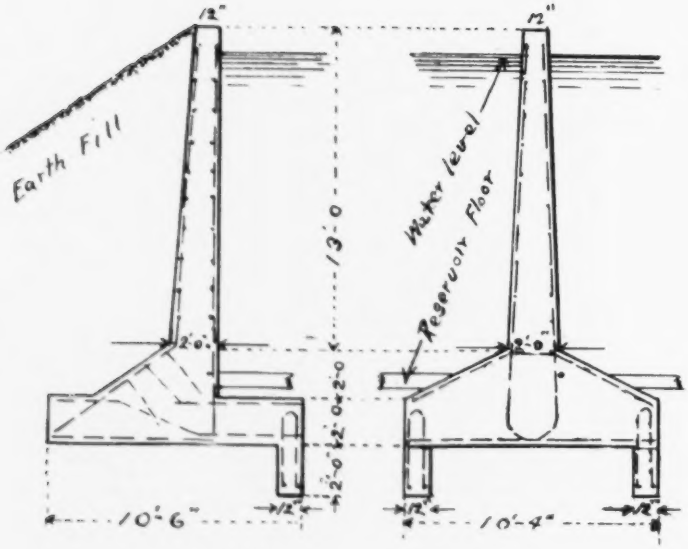
In a stretch of wall of the above section containing 5,008 cubic yards built by the company on force account the cost was (not including excavation) $5.05 for the concrete and $0.75 for the steel, for each cubic yard of the masonry.



The above from the *Engineering Record* shows a wall designed and erected by the L. & N. R. R. Co. in 1908 as a wing wall to an old abutment to bridge over Pigeon Creek just above its entrance into the Ohio. The base is placed on alluvial deposit near the low water level of the Ohio river. The instability of this foundation was indicated by piling previously driven at the edge of the creek in front of the wings. These pilings had been pushed outward several degrees from vertical.

As would be anticipated, the fill with the heavy surcharge caused the foundation at the toe to settle some. In one year the top had moved two inches in the direction of the arrow on plan view. The new wall as a whole showed not a crack of any description, the only crack being where the new had let loose from the old, leaving an opening 1½ inches wide at the top, decreasing to zero at the bottom.

Had the wing been a gravity wall with not more than double the volume of masonry as the one built, the yielding of the foundation would certainly have been much more serious. For with a gravity wall having but double the volume, a base but one-half as broad as that used in the reinforced section could have been obtained. Therefore the pressure on the foundation at the toe would have been not less than four times as much per square foot, as it is now, and the resulting compression of the earth at that point would probably have been in the same proportion.

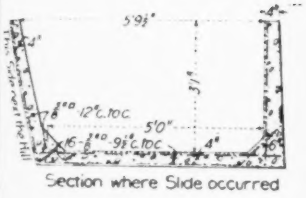


The above walls were constructed in 1908 for reservoir walls at Pine Bluff, Ark. The wall on left hand for the outside and the right hand for a division wall able to resist water pressure from either side with the opposite side empty.

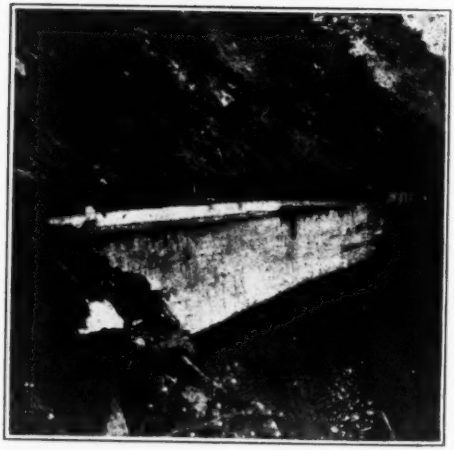
The City Engineer of Pine Bluff, in a letter written in 1913, says regarding these walls: "They have answered their purpose in the most satisfactory manner possible. They have had *no* repairs and are apparently in better condition today than when constructed. They have been in continual use since construction.

Very respectfully,

"F. R. ALLEN, City Engineer."



Section where Slide occurred



The above at the left shows section of a reinforced concrete flume sev-ral miles long, built by the Yakima Valley Canal Company, Washington, to rry water for irrigating purposes. It is located mostly on a steep hillside, e inclined wall being built against the bank, while the vertical is self-sup-rting and also acts to retain the water in flume, the same principle as an dinary cantilever wall retains earth.

The photo at the right shows a point on the flume where an accident ppened, viz., the bank above the flume slid into the flume, causing the ater to overflow and undermine about 50 feet as shown. It failed, how-er, to wreck the structure. The earth was cleared out with no permanent effects to the flume. This flume cost about $2.50 per lineal foot outside the grading. It is giving splendid satisfaction.

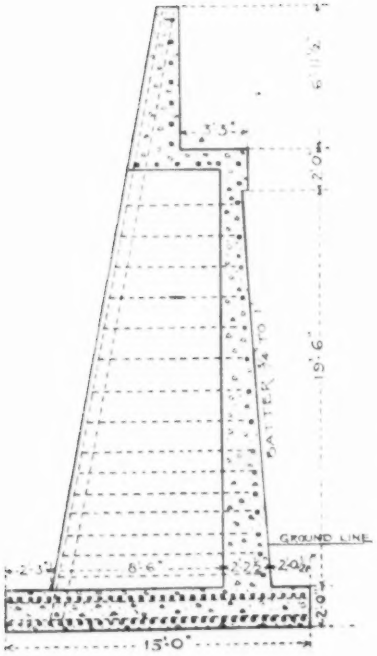
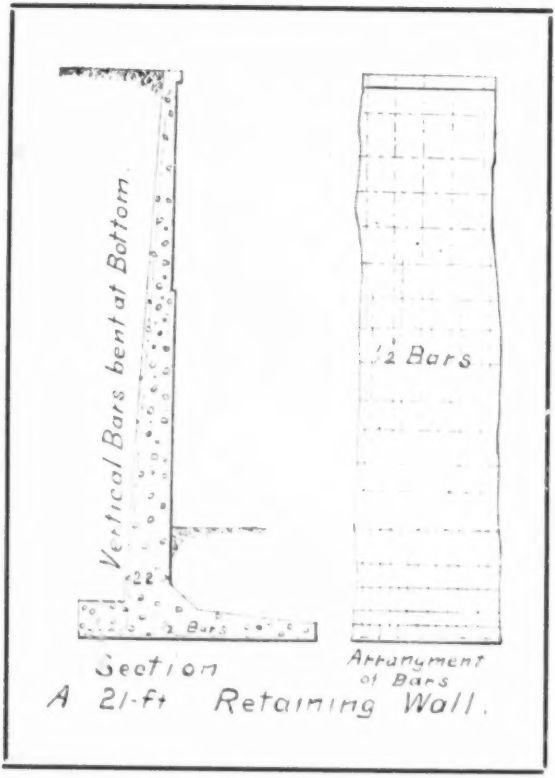


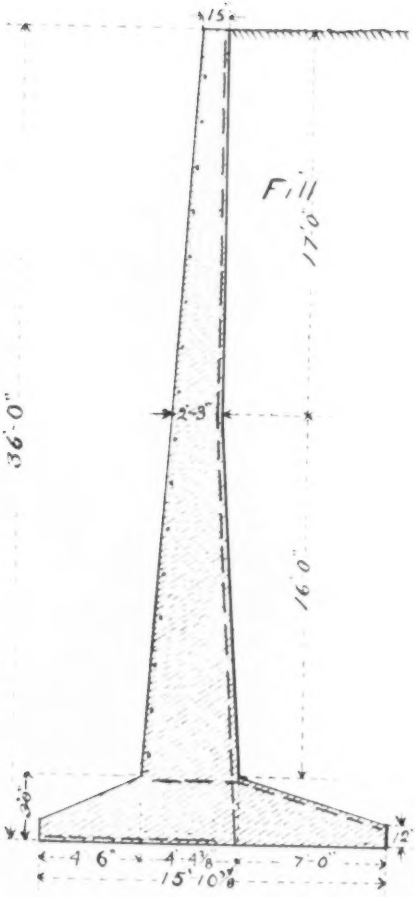
Fig. 15

Section of Abutment on Wabash Railroad at Monticello, Ill.

Fig. 15 shows a section of wall having counterforts at intervals of abo 8 feet, with a thin face wall between, reinforced with horizontal rods. T style of wall is good for abutments of bridges, the counterforts being ma to come under the bridge seats. The style may also figure out stable wa less concrete than a plain T-shaped section, as shown in Fig. 1, by using mo steel, but is more expensive to build per cubic yard; and in Cincinnati, a competitive bidding on the two styles of walls for the same place, both same stability, height and length, the bids showed from 11.6 per cent to per cent in favor of the plain T shape over the wall with counterforts f economy.



The wall shown above was erected in the busiest part of Cincinnati, O., in 1902, and stood as shown during winter of 1902 and 1903, and was subject to continuous heavy traffic of loaded wagons near the top during that time. Afterward a connection was made from the top to the right hand for support of a sidewalk. The reinforcing rods were twisted steel.



This is section of wall erected along Hickory street in Akron, O., in 1908. This wall is referred to elsewhere in this pamphlet as a case where actual list of ten bids shows the city would have had to pay 63 per cent more for a gravity wall of like size and capacity. This wall looks rather light, but after five years' test it is O. K. in all respects.

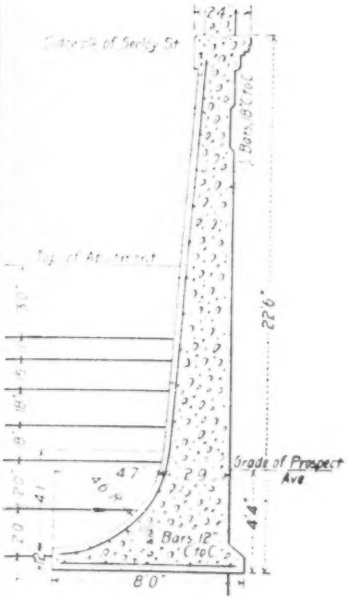


Fig. 13.

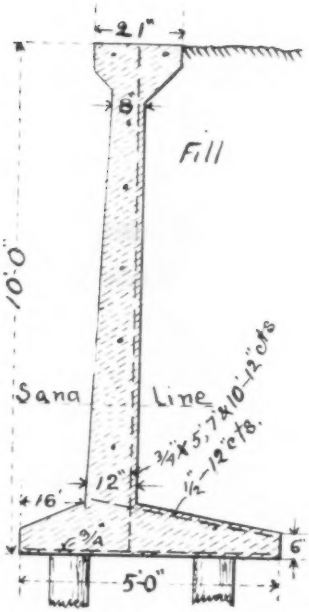


Fig. 14.

Fig. 13 is section of wall built in Brooklyn, N. Y., in 1903.

Fig. 14 is section of wall used by the city of Denver along the banks f Cherry Creek for a distance of about one mile in District No. 2. In District No. 1 a counterfort type of wall had been used, but in this part the ype was changed as shown to the cantilever type.

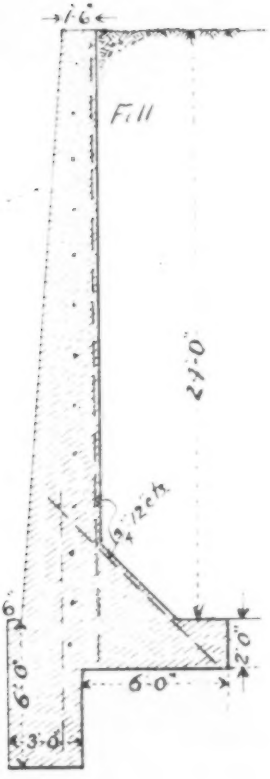


Fig. 20.

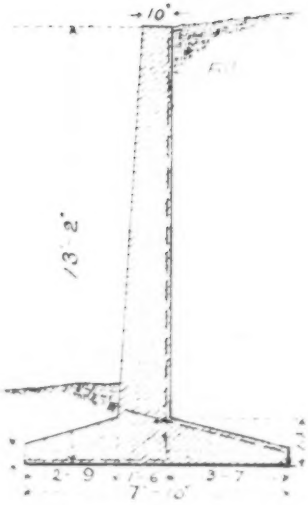
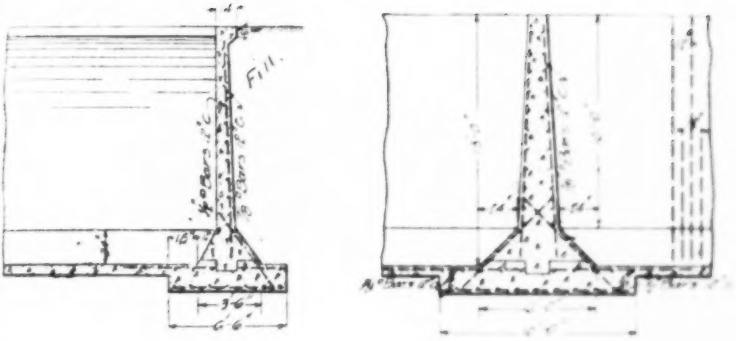


Fig. 21.

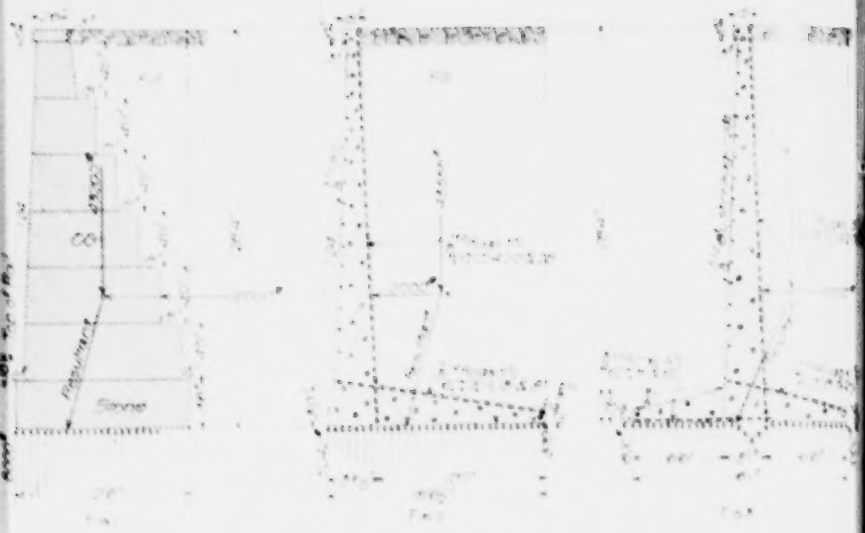
Fig. 20 is section of wall erected at Crawford Run ditch, Hamilton Co., by Butler County Commissioners.

Fig. 21 is section of wall built by Eagle White Lead Company at its plant in Cincinnati, O. This is a typical wall of great stability.



The above shows the type of walls used for reservoir of water works built in connection with the Panama Canal. The wall at the left is for the outside wall and is designed to support the earth fill with no water on the inside as well as with the reservoir filled. The wall at right is a partition wall and is designed to support either side filled with water and the opposite side empty.

The fact that this type of wall was selected by a department composed of the very best qualified engineers in the world is evidence of the superior quality of this type of wall construction.



A Comparison of High Walls.

Cantilever walls by many are not considered economical for heights of over 20 feet. A comparison of the above, however, shows that a large saving can be effected with a superior stability.

Fig. 1 is a gravity wall used by the D., L. & W. R. R. along the side of their tracks. The outward pressure of a wall of this height for ordinary material would, according to Trautwine's formula, be 12,000 pounds per lineal foot. This would cause a down pressure on the toe of 8,000 pounds per square foot. The same loads on Fig. 2 causes a pressure at toe of 5,242 pounds and the same co-efficient of fraction as to sliding forward on base as Fig. 1. The same load on Fig. 3 brings a down pressure on the toe of 1,600 pounds. This last is the typical wall for poor foundations and locations where an extended toe is permissible and where there is some earth in front of the wall. The only place the factor of safety is less is in liability to slide forward.

Comparative costs would be about as follows:

Fig. 1. 8.15 cubic yards at $6.00		$48.90
Fig. 2. 3.12 cubic yards at $7.00	$21.84	
180 pounds steel at $0.03	5.40	
Extra excavation, 3 yards at $0.50	1.50	
Extra rock fill, 5 yards at $0.30	1.50	30.24

The cost of Fig. 1 being 64 per cent more than Fig. 2. The cost of Fig. 3 is still less as there is less concrete, less steel and less excavation and back fill.

The internal strength of the reinforced walls is such that they would fail by overturning long before rupture would occur. The factor of safety against settling under the toe (where most failures occur) is far greater in the reinforced walls.

The above demonstrates that for high walls the counterfort walls are not only cheaper, but are also better than gravity walls. The higher the wall the greater the economy of reinforced walls when compared with gravity walls.

Patents

We control the pioneer patent in the United States for this kind of construction, and have others pending. Thorough investigations were made as to its validity before purchase by this company. To protect our interests we have already begun suits against infringers, and will vigorously prosecute the same to the limit if compelled to do so. Our patent, No. 705,732, is not confined to a few narrow detail claims, but contains seventeen claims, many of which are quite broad. For example, such as "A retaining wall having a heel (strengthened by metal within and connected with braces in the wall by suitable brace rods) extending to the rear of the base, upon which the retained material rests and acts by gravity to keep said wall in its normal position." It can be plainly seen that this is not limited to a special system of reinforcing a wall having a heel on which the earth rests, and acts by gravity to maintain the said wall in position.

With regard to public lettings, it has been decided again and again by the highest courts that when bidders are given the opportunity to buy the right to build the patented structure, the competition is genuine, and the letting of such a structure is legal.

Our Business Methods

It is our object to get substantial reinforced concrete retaining walls built by our system, thus getting a chance to prove their merit. To accomplish this, our engineering force has for a number of years made a study of retaining walls, and is devoted exclusively to their design and construction. We have developed a systematic method of design and of collecting data from the action of walls previously built. With the experience thus gained we will prepare plans free of charge to those contemplating the construction of any wall, depending upon their merit to secure adoption. These

plans may be put on file in competition with other designs for any contractor to bid on, or the engineer or architect may incorporate them in his own plans. Where desirable, we will make propositions to take the contract to build the wall ourselves, including royalty in the bid.

It is satisfactory to us, of course, for the engineer, if he wishes, to make his own design, or for the owner to employ any engineer, and we will gladly consult with him on any point. Our compensation is for the use of our patent, and is based on a percentage of the contract price. Or we are willing to take as our compensation a small percentage of the saving in cost effected by the use of our system as compared with any other.

We desire to secure representatives in every city and county, either contractors or engineers, who will be on the ground to watch for work to be done in their vicinity. We will give good inducements, and, by reason of our patents, are in shape to and will protect those who work for us.

Design

It is easy to design a reinforced concrete wall of the same stability of any example of solid wall that may be selected. The heel can be made of sufficient length so that the earth on the heel, together with the wall, will be just as heavy as the example. The concrete steel beams can be made strong enough to resist the same force which will not overturn the wall as a whole. But a reinforced wall so designed does not get the full benefit of the advantages which it has over a gravity wall. So it is better to use methods of design which are somewhat different from those commonly used for retaining walls. The formulas herein given determine the proper dimensions which a wall should have to best resist failure, considering the probable earth thrust and the bearing power of the foundation bed on which the wall is to be built.

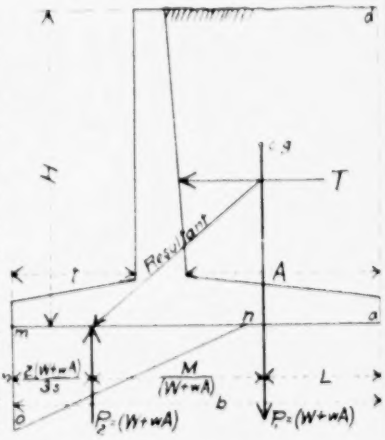


Fig. 18.

EARTH THRUST.—Many complex theories have been devised to calculate the earth thrust. But the assumptions on which these theories are based are so variable and hard to determine with accuracy that they give far from practical results. However, they are the best at hand, and serve

to obtain results much better than by direct assumptions. Rankine's is one of the standard formulas, and can be expressed as

$$T = \frac{w \ H}{2} \left(\frac{1 - \sin\phi}{1 + \sin\phi} \right)$$

Where T equals earth thrust, H equals height of wall, w equals weight per cubic foot of backing = 11, and ϕ equals the angle of repose. What few experiments have been made to verify these formulas indicate that the actual earth thrust under a backing of certain weight and angle of repose is about one-half of the calculated value. The angle of repose is taken as the smallest angle at which the given earth will repose, and is seldom less than 35 on 1. This will give the maximum normal earth thrust. However, in actual cases the earth will probably repose at a steeper angle, due to the cohesion in the earth, and the earth thrust will be less. This maximum normal thrust can now be multiplied by a factor of safety to get the ultimate value. We use a factor of safety of 3 or 4 for external stresses and 6 to 8 for internal stresses. These factors are large, the factors for gravity walls seldom being taken over 3. With a more economical structure we can afford to use a larger factor of safety.

A reinforced wall may fail (1) internally or (2) externally. It may fail externally (a) by overturning, or (b) by sliding forward on the base.

SLIDING.—To produce sufficient friction between the base and the foundation to prevent sliding the heel must be made of such a length as to get a sufficient weight of earth upon it. This length of heel is expressed by the formula

$$T = f \left(W + x \ A \right) \quad \text{or} \quad A = \frac{T - f \ W}{f \ x}$$

Where f equals the coefficient of friction, W equals weight of wall and x equals weight of one cubic foot of backing, multiplied by the height.

OVERTURNING.—The resultant earth thrust is assumed to act at one third of the height (H) of the wall from the base. The overturning moment then is

$$M = T \frac{H}{3}$$

To obtain the proper length of the base to resist this overturning moment, and to prevent crushing or settlement of the earth under the toe,

$$b = \frac{2\,(W \cdot a - A)}{s\,b} + \frac{M}{(W \cdot a - A)} + L$$

(See fig. 18), where L equals distance of the resultant center of gravity of the wall and earth on the heel, from the end of the heel, and s equals the bearing power of the foundation bed. If the foundation bed is liable to serious settlement, the position of P_2 under the maximum normal earth thrust is found, and the toe extended until P_2 cuts the base in the middle. This will keep the unit pressure the same all along the base and the settlement uniform.

INTERNAL STRESSES.—To prevent internal failure, the concrete steel beams are figured by the usual methods of concrete steel design. In the inverted T or L type of wall the trunk, the heel and the toe are simply cantilever beams. The moment on the trunk is produced by the earth thrust. The moment on the toe is produced by the reaction of the foundation acting upward. This reaction is represented by the part of the triangle nmo (Fig. 18) directly under the toe. The moment in the heel is produced by the weight of the earth on the heel, the force due to friction in the plane aa' and the reaction, if any, on the foundation, acting negatively. This reaction is represented by the part of the triangle nmo directly under the heel. The distribution of the stresses in the heel and toe vary greatly under different loads. So the stresses in the base should be considered for the various possible loadings.

INTERNAL STRESSES OF COUNTERFORT WALLS.—In counterfort walls the counterforts or ribs are reinforced sufficiently to carry the load of an entire panel length. The stresses caused by the pressures in the face and base must be carried from their points of application to the counterforts, by a slab construction. These slabs act as continuous beams and must be reinforced on each side of the slab at proper places. The variation of the position of the stresses in the base under different loads necessitates an analysis of the stresses for all of the possible loadings. In some parts of the slab the tension may sometimes be on one side and sometimes on the other, requiring rods on both sides of the slab, and the pressure may be concentrated on one part or it may be distributed. The action of continuity which occurs at the juncture of the face with the floor slab requires vertical rods in the back part of the face slab, continuing down along the top of the base. The positions of the shearing stresses under the various loads must be determined and resisted. A larger factor of safety

ould be allowed a counterfort wall than a T wall, in regard to internal resses, because in a T wall the rods act strictly in series, and, being merous, a defect or failure in one would be of little importance, while a counterfort wall a defect in one member might endanger the wall for an tire panel length. Also, in the thin slabs that are used in counterfort walls slight displacement in a rod makes considerable difference in the strength the slab, while an equal displacement in a rod of a thicker beam as used T walls would not make such a difference in its strength.

Any decreased dead load obtained by rib or counterfeit construction es not give the advantage to retaining walls that it does to floors of ildings or bridges, because the weight of the beam itself, in the case of lls, is an aid to stability.

NOTE. For complete data and charts for designing retaining walls, e article in Eng. News, April 25, 1907, by E. P. Bone, C. E.

Prof. Arvid Reuterdahl, author of "Theory and Designs of Reinforced oncrete Arches," says: "I wish to state that this article is without excepon the best thing ever written on reinforced concrete retaining walls, and e engineer who possesses a copy has a fund of information that is invalude."

Reprint of above article mailed on receipt of 6 cents in stamps.

In the United States District Court,

Northern District of Ohio,

Eastern Division.

FRANK A. BONE, Complainant, vs. THE CITY OF AKRON, Defendant.	IN EQUITY, No. 128

MEMORANDUM OPINION.

Day, District Judge:

In this present case it appears from the record that

is a true and correct copy of the original filed in the case.

EDWIN DRAKE, Official Court Reporter.

Cleveland, Ohio, May 13, 1913.

invention consists in embedding in retaining walls of concrete, stone or brick, a frame or skeleton of metal arranged in certain relations to the stresses which the wall is required to withstand. The object is to obtain ample resistance to breaking, bulging, over-turning or settling with a smaller volume of masonry than would be required for the ordinary gravity wall of equal strength and stability. The patent describes and illustrates a concrete wall consisting of a thin vertical wall having an extended heel and toe reinforced in the upright portion by upright metallic members at the back part of the wall and in the heel by metallic members extending obliquely along the upper part and in the toe by metallic members extending transversely along the bottom.

The reenforcing members are placed near the back face of the wall and heel and near the lower face of the toe. The oblique reenforcing bars in the heel acting in conjunction with the uprights serve the function of a cantilever beam whereby the weight of the material pressing upon the heel is transferred to the upright portion of the wall and operates to retain the wall in a vertical position.

This wall described by the patent uses the weight of the retained material to retain itself; while in the gravity wall which was old in the prior art, the resistence to overturning is the wall itself.

The claims of the patent in controversy are the first, second, third, fifth, sixteenth and seventeenth. Without referring in detail to these claims, the elements called for by the claims consist of the wall with its heel and toe, the upright bents in the body of the wall, the oblique bents in the heel and the series of rods in the toe, the latter being called for in claim 16, only. The blue print which is in proof and which shows the outline and drawings for the alleged infringing device, discloses a retaining wall of concrete consisting of a slender

I hereby certify that I wrote the above entitled

that I personally submitted the same to the said Judge

vertical wall with inclined heel and toe; this wall is reenforced by a series of upright bents, embedded within the back part of the vertical wall, and continuing obliquely, or in an inclined direction, along the upper part of the heel to the back thereof. The curve of the wall is reenforced by a series of metal rods extending transversely. In addition to the series of bents extending down the back of the wall and into the heel, there is a series of upright bents extending to the bottom of the wall and intersected and overlapped by a series of inclined bars extending along the upper part of the inclined heel.

Considering the claims of the patent, and the testimony, I am of the opinion that Bone, the patentee, was the first to reenforce the retaining wall, or similar wall of concrete or masonry in such a manner that the weight of the retained material would be utilized to impart through the reenforcing members tensile resistence to the stem or vertical part of the wall, thereby fortifying this part of the wall against breaking strains.

This was an advancement in the art and possessed novelty and the structure of the defendant city infringed this patent.

While many of the features of concrete structures were old, yet this combination as outlined and described in this Bone application for a patent, was new. It is also in evidence that there has been a large sale and general acquiescence in the Bone patent.

I accordingly reach the opinion that the claims of the patent sued upon are valid; that they have been infringed, and that the complainant is entitled to relief.

Perhaps the damages would not be any more than the loss of royalty in reference to this particular structure referred to in the proofs, but an order may be drawn in accordance with this memorandum.

Day, Judge.

opinion at the dictation of Judge William L. Day;

for inspection and correction, and that the foregoing

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United States Circuit Court of Appea

Sixth Circuit.

THE CITY OF AKRON,

Appellant,

vs.

FRANK A. BONE,

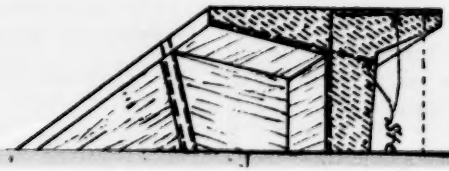
Appellee.

No. 2562.

Appeal from the Dist. Court of the U. S. for Northern District of Ohio, Eastern Division,

Submitted Feb. 10, 1915. *Decided March 2, 1915.*

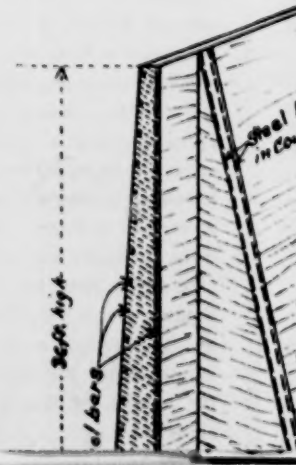
The above shows in perspective the back of wall specified and built by the City of Akron.



NOTE.—In settlement of this case after three and one-half years' litigation the City of Akron paid the Plaintiff as royalty and damages a sum equal to three times the usual rate, or 30% of the contract price of the wall in question. That being the amount claimed under the statute allowing triple damages.

testimony that the specifications were departed from in some particulars; but, if this departure was material, the burden was upon the city to show its extent, and this the city did not do.

It is said that the Ohio Laws forbid a city to let a contract which involves the use of a patent, excepting upon conditions which were not followed here (Hastings v. Columbus, 42 O. St., 585), and that, accordingly, the agents of the City are personally liable and the city is exempt. We cannot accept this conclusion. The action of infringement rests on tort, not on contract, and the position of the defendant seems to be that a city is not liable for a tort, unless the tort is lawfully committed. Such a description of a tort is difficult to apply. To deny an infringement injunction against a city is to say that because the city has wrongfully taken plaintiff's property it may continue to keep it and use it. The liability of a municipal corporation for infringement has been recog-



nized in this court (Warren v. Owosso, 166 Fed., 309; Grand Rapids v. Warren, 196 Fed., 892) as well as by the Supreme Court (Elizabeth v. Pavement Co. 97 U. S., 126) and expressly upheld (May v. Logan Co., Jackson, C. J., 30 Fed., 250).

Under the familiar rules concerning torts by agents of municipalities, it would seem that if the agents in adopting the infringement went outside the scope of their duty, and if the city itself did not continue the infringement after notice of what the agents had done, there might be no liability for damages; but this is not the case. The municipal officers who built this wall had clear authority to obtain the use of the patent, by following a prescribed method. In appropriating the patent without permission, they were acting within the scope of their duties though in violation of specific restrictions, and the city is liable in damages for their tort.

The decree is affirmed, with costs.

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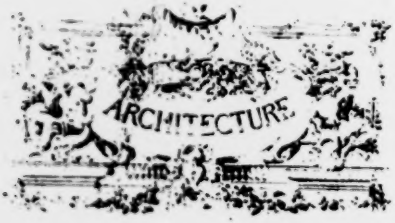
NEUVIÈME ANNÉE

LA CONSTRUCTION MODERNE

JOURNAL HEBDOMADAIRE ILLUSTRÉ

DIRECTEUR P. PLANAT

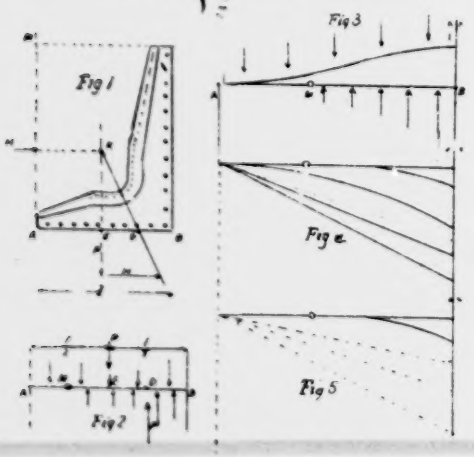
ART, THÉORIE APPLIQUÉE, PRATIQUE



GÉNIE CIVIL, INDUSTRIES DU BATIMENT

PARIS
AULANIER & Cie, ÉDITEURS

1893-1894



DEUXIÈME SÉRIE — 1re ANNÉE
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LA

CONSTRUCTION MODERNE

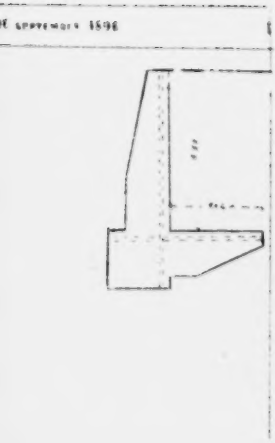
JOURNAL HEBDOMADAIRE ILLUSTRÉ

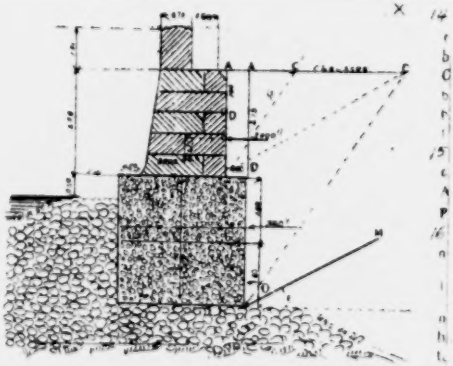
DIRECTEUR P. PLANAT

ART. THÉORIE APPLIQUÉE. PRATIQUE

GÉNIE CIVIL. INDUSTRIES DU BATIMENT

PARIS
AULANIER & Cie, ÉDITEURS
15, RUE SAINT-BENOÎT, 15
1895-1896





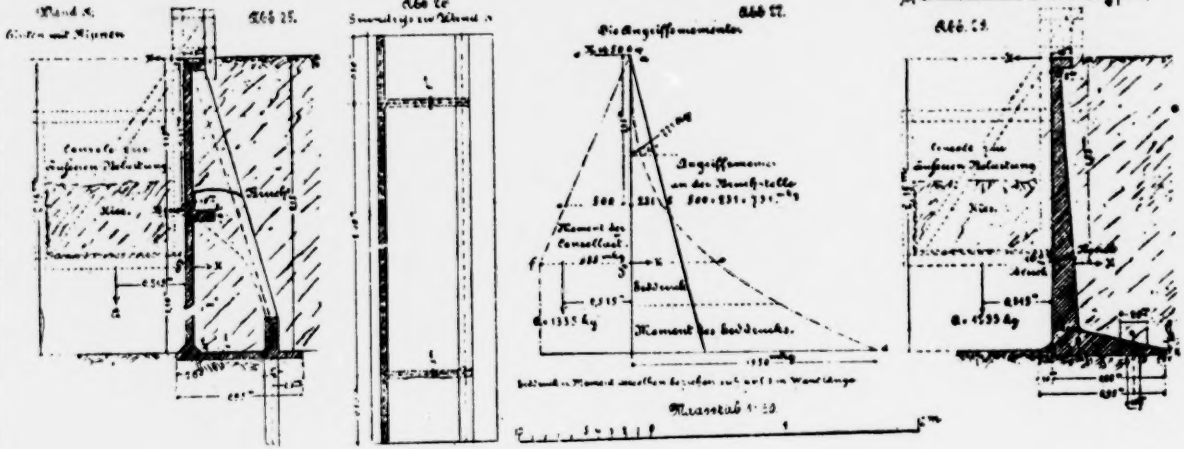
Empirische Untersuchungen im Bau-Ingenieurfach, insbesondere an Beton-Eisenkonstruktionen ausgeführte Bruch-Belastungen.

(Schluss.)

d) Die Winkel-Stützwand, mittels Zement-Erdanker gehalten.

Diese Stützwand, auf welche Gebrauchs-Musterschutz ertheilt ist, besteht aus einem stehenden und einem liegenden Schenkel. Beide sind steif mit einander verbunden. Die Verhältnisse sind so gewählt, dass die Resultirende des Erddrucks durch den liegenden Schenkel bezw. durch das Fundament geht, Zement, 3 Th. Sand, 1½ Th. Harzer Pochkies und 1½ Th. Gabbro-Schotter. Wegen der sehr geringen Wandstärke konnte aber nur zu kleines Steinmaterial verwendet werden, worunter die Bruchfestigkeit des Betons gelitten hat.

Die verwendeten Eisenanker bestanden aus nur 3 bzw. 7 mm starken Drähten. Es war beabsichtigt, den Eisenankern eine solche Stärke zu geben, dass, soweit das Eisen infrage kam.



TIJDSCHRIFT 121

VAN HET

KONINKLIJK INSTITUUT

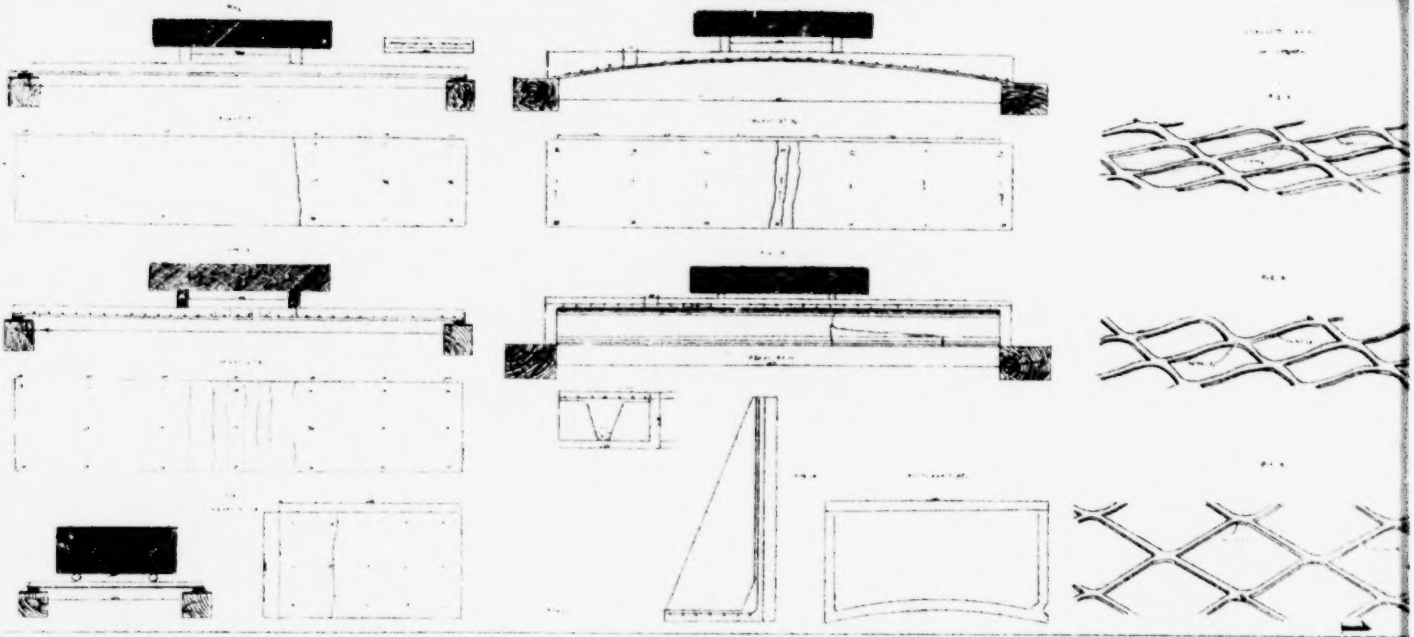
VAN

INGENIEURS

VERHANDELINGEN. VERTALINGEN.
VERSCHEIDENHEDEN BOEKAANKONDIGINGEN.
NIEUW VERSCHENEN WERKEN.

INSTITUUTSJAAR
1895–1896.

TE SOMAVENHAGE.
BIJ GEBRS J & H. VAN LANGENHUYSEN.
1896.



123

371
Bonn
v.
Marion Co } p 123

Ausgewählte

Monier- und Beton-Bauwerke

Strassen- und Eisenbahnbrücken

Hochbauten, Silos, Futtermauern, Kanäle u. s. w.

nach den Ausführungen der Actien-Gesellschaft für Monierbauten

bearbeitet

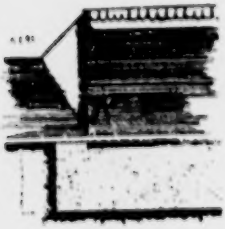
von

F. Rehbein, Königl. Regierungs- und Baurath.

Zweite vermehrte Auflage

Berlin 1894.

Verlag und Druck von Julius Becker, Berlin S., Blücherstrasse 38



Strassen-Brücke bei Buddenbrock.

37 Bogen } ϕ 17
Mauer 60

129 (Endorsed:) Duplicate 7293. Statement of Evidence Lodged Dec. 22, 1916. Filed Dec. 27, 1916. Noble C. Butler, Clerk.

(Cuts and translations of Bauzeitung article, not on file.)

Abstract of File-wrapper and Contents of Letters Patent No. 629,477.

Abstract of File-wrapper and Contents of the Patent to Charles F. Stowell and Andrew C. Cunningham, #629,477, July 25th, 1899, for Improvement of Walls, said Copies Being Duly Certified by the Commissioner of Patents on December 9th, 1914.

(The drawings are the same as are set forth in the patent as issued, see page —.)

Div. IV.

(Serial Number) 629,272. Div. —. (Ex'r's Book) —.

1897.

Patent No. 629,477:
Charles F. Stowell and Andrew C. Cunningham,
Of Albany,
County of ——,
State of New York,
Invention: Walls.

Petition,	Mar. 25, 1897.
Affidavit,	" " "
Specification,	" " "
Drawing, 4 shts.,	" " "
Model, None.	
Specimen, —,	
First fee, Cash, $15,	Mar. 25, '97.
" " Cert.	

App. filed complete Mch. 25, '97,
Examined June 7, 1899. B. W. Pond, Ex.
Countersigned: J. W. Babson,
For Commissioner.
Notice of allowance, June 7, 1899.
Final fee, Cash, $20, July 3, 1899.
" " Cert., —— —, 1899.
Patented July 25, 1899.
Benj. R. Catlin, City.

130 *Specification.*

To all whom it may concern:

Be it known that we, Charles F. Stowell a resident of Albany in the County of Albany and State of New York and Andrew C. Cun-

ningham a resident of Albany in the County of Albany and State of New York have invented certain new and useful improvements in Walls, and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

The invention relates to walls for sustaining the pressure of earth, water, or other solids or liquids, or of superimposed loads, or both; such as retaining walls, dams, reservoir walls, piers, abutments, dikes, levees, bulkheads, tanks, revetments and the like. It has for its object to increase the stability and durability of such walls, and the invention consists in the construction hereinafter described and particularly pointed out.

In the accompanying drawings

Figure 1 is an isometric view, partly in sections;

Figure 2 is a section on line 2—2 of figure 1;

Figure 3 is an isometric view, partly in section, of a modification;

Figure 4 is an isometric view, partly in section, of a modification of a different kind.

The improved wall is constructed of plates of iron, steel, or other suitable metal, stiffened at the top, bottom, sides and such intermediate points as may be necessary, by angle iron or other suitable stiffeners, and braced at suitable intervals by knee braces attached to the wall or face plates, the whole being covered on one or both sides by a layer of cement, mortar or concrete, and resting on a concrete foundation to which it is fastened by bolts or other suitable means at proper intervals. The weight of the mass of material superincumbent above the foundation keeps the latter in place and prevents overturning, while the foundation itself is stiffened and strengthened by embedding in it iron or steel in the form of beams, channels or other suitable forms in order to prevent the foundation from breaking between the knee braces.

In the drawings *a* represents the metal face plate stiffened with angle iron or like means along the edges as shown at *b* and *c*. A knee brace, *d*, is shown, riveted or otherwise secured to the
131 face of the plate as indicated at *e*. The knee brace and face plate may be bolted to foundation I beams and channel beams of metal as indicated at *f* and *g* in the drawings. The improvement is however not limited to the particular form of these foundation beams shown in the drawings nor to beam stiffeners. The face plate is backed by a suitable concrete or cement covering and the braces and foundation beams or other stiffeners are embedded in the same. Concrete is denoted by *h* and earth or other superposed material *k*.

The front face of the plate can also be covered with concrete as indicated in figure 3, or the front face only of the plate can be so covered, leaving the rear face and braces exposed, as indicated in figure 4. Figure 4 further illustrates a different form of knee brace from that indicated in the other figures, the form and construction of the knee braces not being essential. Figure 4 also shows face plates constructed of buckle plates instead of flat plates, such construction being advantageous to certain cases, and it illustrates a modification of the method of stiffening and strengthening the foundations by

the use of expanded metal instead of I beams as shown in the other figures. A portion of the concrete foundation in figure 4 is represented as being removed to show the plate of expanded metal embedded in the concrete.

It should be understood that — the ferm concrete we wish to include any equivalent, such as cement. Instead of or in combination with bolts any suitable means — be employed for fastening the parts together. Instead of foundation bars, such as illustrated, angles, flat or round bars, plates, pipe, woven wire, wire cloth, perforated or expanded metal or other forms may be used, either flat or arched, or two or more of these forms of stiffeners, may be combined. It is not essential that the stiffeners, or stiffeners and braces, be entirely covered with cement in all cases, particularly if some parts be accessible for painting, and it is opt*(*ional whether all or any of the front or face plates, or all or any of the rear of the face plate or the knee braces be covered with concrete or the like.*) It is im-

Substitute C, Aug. 11, '97.

132 portant that the face plate and foundation be firmly connected so that the latter shall resist a pressure tending to overturn the structure and resist pressure due to a load, and that the foundation be stiffened to resist upheaval between the braces and that all inaccessible parts be protected by a preservative covering.

The advantage of this form of construction over brick or stone masonry are, less cost and greater facility of erection for a wall of equal strength; impermeability to liquids, such a wall being proof against leaks, while should the wall be punctured by design or otherwise the hole is not liable to enlargement by erosion and can be easily repaired. The wall is absolutely safe against the attacks of water rats or other burrowing animals which often cause destruction of earth embankments. It is also free from liability to destruction in consequence of local defects such as the disintegration of a stone or brick, or locally defective workmanship. It has greater ability to sustain shocks or collisions than a brick or stone wall of equal strength, and has less liability to failure in case of undermining of the foundation than a brick or stone wall, the improved wall being self-sustaining over a much greater span.

In constructing our wall as specified we utilize the well known property *or* concrete *of* cement mortar that it is one of the best known preservatives *or* iron or steel against rusting, and all portions of the wall which are not exposed to view are covered and protected by such preservative substance, while only portions that are readily accessible for covering with paint or similar preservative coating are left exposed. We also take advantage of the further facts that the adhesion between iron or steel and concrete or mortar is very great, and that their ratios of expansion and contraction by heat are substantially alike so that the bond between them is not broken by changes in temperature.

133 Insert A, May 7, '97.
Insert D, Aug. 11, '97.

*Matter in italics in parentheses stricken out in original transcript.

Having thus described our invention what we claim and desire to secure by letters patent of the United States is:—

Substitute B, May 7, 1897.

*(*1. In a wall for sustaining pressure, metal face-plates, a covering of concrete or the like, and foundation stiffening devices embedded in the concrete, substantially as described.*

2. In a wall for sustaining pressure, metal face-plates, a covering of concrete or the like, and foundation stiffening devices embedded in the concrete, said stiffening devices and face plate being fixed together, substantially as described.)

4 *(3). In a wall for sustaining pressure, metal face-plates, a covering of concrete or the like, and foundation stiffening devices embedded in the concrete, and braces also embedded in concrete and secured to the face plate and to the stiffeners, substantially as described.

5 *(4). In a wall for sustaining pressure, metal face-plates, a covering of concrete or the like, and foundation stiffening devices embedded in the concrete, said face plates and foundation stiffeners being secured together by braces and the braces, stiffeners and the back of the plates covered with continuous body of concrete, substantially as described.

In testimony whereof, we have signed this Specification in the presence of two subscribing witnesses.

CHARLES F. STOWELL.
ANDREW C. CUNNINGHAM.

JOHN D. WILKINS,
ENRIQUE A. FONCEDA,
Witnesses.

134 *Oath.*

STATE OF NEW YORK,
City & County of Albany, ss:

Charles F. Stowell and Andrew C. Cunningham the above named petitioners, being duly sworn, depose and say that they verily believe themselves to be the original, first and joint inventors of the improvement in Walls described and claimed in the foregoing Specification; that they do not know and do not believe that the same was ever before known or used; that they are citizens of the United States, and that the said Charles F. Stowell is a resident of Albany, in the County of Albany and State of New York and the said Andrew S. Cunningham is a resident of Albany in the County of Albany and State of New

*Matter in italics in parentheses stricken out in original transcript.

York; that the said invention has not been patented to them or with their knowledge or consent to any other person in any foreign country; and that the same has not, to their knowledge, been in public use or on sale in the United States for more than two years prior to this application.

CHARLES F. STOWELL.
ANDREW C. CUNNINGHAM.

Subscribed and sworn to before me, this 19th day of March, A. D. 1897.

[SEAL.] W. C. ROSE,
Notary Public.

Serial No. 629,272. Paper No. 1 / 2 Appn. Filed Mar. 25, 1897. Stowell and Cunningham.

Patent Office Letter, Dated May 4th, 1897.

Charles F. Stowell and Andrew C. Cunningham, care Benj. R. Catlin, City:

Walls, filed March 25th, 1897; Serial No. 629,272.

BENJ. BUTTERWORTH.

E. B. MOORE,
Commissioner of Patents.

This case has been examined.

The 1st and 2nd claims are met in Figures 3 and 3ª of English patent 2968 of 1877 and Figs. 12 and 13 of English patent
135 289 of 1877 (Concrete and Metal). In view of the well known practice of embedding webbed beams in concrete, the substitution of a continuous web or plate in said English structures in lieu of the spaced bars is not patentable invention. See also English patent 3579 of 1876 (same class), which shows, also, in Fig. 7, such use of webbed beams. The deep web of the I-beam is within the term metal face plates.

The 1st and 2nd claims are rejected.

B. W. POND, *Ex.*

F. P. LYBRAND,
4th Asst. Exr.

Serial No. 629,272. Paper No. 1 Rej. Dated May 4, 1897. Stowell and Cunningham.

Washington, D. C., May 6th, 1897.

Hon. Commissioner of Patents.

SIR: In the application of Charles F. Stowell and Andrew C. Cunningham, for Walls, filed March 25th, 1897: Serial No. 629,272, amend as follows.

Insert immediately before preamble to claims:

A. "We are aware that metal beams, lath and such like structures have been embedded in cement and this matter is not of our invention. Our improvement relates primarily to structures exposed to the action of water, floating ice or other objects and to the attack of animals and in which an opening however small when once found is liable to be speedily enlarged to the destruction of the entire structure or a very material part of it, and it comprises continuous plates either integral or jointed in sections thereby presenting a continuous defense of practically uniform character to blows or attacks, and also providing against the enlargement by flowing water of an opening if one is formed notwithstanding the continuous protecting plate. It also comprises foundation stiffening devices embedded in concrete continuous with the concrete covering of the plates whereby floating undermining and sinking are obviated—"

136 Erase claims 1 and 2 and substitute—

Subs. E. Aug. 11. '97.

B. *(*1. In a wall for sustaining pressure on a face thereof, a metal plate co-extensive with the exposed face of the wall, a covering of concrete or the like for the plate, and foundation stiffening devices embedded in the concrete, substantially as described.*)

2. In a wall for sustaining pressure, a metal face plate, a covering of concrete or the like, and foundation stiffening devices embedded in concrete, the concrete covering the plate and foundation being continuous and said stiffening devices and face plate fixed together, substantially as described.

Subs. E. Aug. 11. '97.

*(*3. In a wall for sustaining pressure a continuous metal plate having a covering of concrete for the wall continuous with the concrete plate-covering substantially as described.*)

Change ordinals of claims 3 and 4 to 4 and 5 respectively.

Remark.

The references though pertinent are not sufficient and their pertinence is more seeming than real since they contain no clear suggestion and still less any practical disclosure of applicants' improvement. There is nothing to suggest a continuous metal pro-

*Matter in italics in parentheses stricken out in original transcript.

tecting plate, but the contrary. The patents so far as they relate to iron structure undoubtedly suggest the saving of weight, material and cost by *not* making any metal parts continuous to cover the entire face of a wall. These structures are so different in their uses and purposes from those specified by applicants that such pertinence as they may be thought to have is materially weakened. They belong to different arts. The structures described are not intended to resist hydrostatic pressure as in dams or levees and they are not appropriate for the objects names in applicants' specification and would not be practically operative.

Applicants more fully distinguish their improvement and solicit an allowance.

Respectively,

BENJ. R. CATLIN,
For Applicants.

137 *Extract from File-wrapper Contents of Bone Patent in Suit.*

Original Claims as Amended.

Substitute C, Apr. 17, 1900.

(1. In a retaining wall the combination with a
Mar. 17, 1900. wall of masonry, a series of *tapering* upright metal members embedded within the interior of said masonry and located and following continuously as near as *practical* the line of greatest tensile strain in said wall from the back part of the heel to a point near the top and having such shape, connections and strength, as may be needed to take up and resist the tensile strains in said wall, substantially as described.)

2. In retaining walls the combination with a wall
Apr. 17, 1900. of masonry, a series of *tapering* upright bents or
Mar. 17, 1900. *members* of metal *braces* imbedded within the interior of said masonry at the back part, only, of the vertical portion and continuing down along the upper part of the heel of said wall to the back part
Apr. 17, 1900. thereof, substantially as (shown) and for the purposes set forth.

Substitute D, Apr. 17, 1900.

(A retaining wall having a heel strengthened by
Mar. 17, 1900. metal *braces* embedded therein extending to the rear of the base, in combination with the retained material resting on said heel, and acting by gravity to keep said wall in its normal position, and thereby keeping retained material itself in its place, substantially as described and shown.)

Mar. 17, 1900. 4. A retaining wall having a heel (strengthened by metal within) *and connected with braces in the wall by suitable brace rods* extending to the rear of the base, upon which the retained material rests and acts by gravity to keep said wall in its normal position, substantially as described.

138 Substitute E, Apr. 17, 1900.

Mar. 17, 1900. (5. A retaining wall having a toe extending to the front in combination with a series of strengthening rods *provided with enlarged ends and* embedded in said toe near its lower side, substantially as shown and for the purpose set forth.)

Mar. 17, 1900. Apr. 17, 1900. Apr. 17, 1900. 6. In a retaining wall, a series of tapering *bents embodied in said wall* (bents) composed of the upright *member c* base *g* and the brace *f* in combination with the masonry substantially as *described* (shown above).

Mch. 17, 1900. 7. In a retaining wall, a series of bents of metal in the back part of the said wall extending down along the upper part of the heel, and a series of strengthening rods *k provided with enlarged ends and embedded* in the lower part of the toe of said wall, in combination with the masonry of said wall, substantially as described.

Apr. 17, 1900. 8. In retaining walls a series of bents composed of the tapering upright *member c* having flanges *b* the tie brace *f* and base brackets *g* in combination with the masonry, substantially as and for the purpose set forth.

Apr. 17, 1900. 9. In retaining walls, a series of upright bents tapering in size and strength from the base to the top, *angle rods i and braces f between said rods and said bents*, in combination with the masonry, substantially as described and for the purpose set forth.

Substitute H, May 16, 1901.

(10. In retaining walls, the bracket *c* attached to upright *c* in combination with said upright and the masonry A substantially as and for the purpose set forth.

Apr. 17, 1900. Apr. 17, 1900. 11. In retaining walls the anchor bars *d* attached to the bracket *c* in combination with the upright *member c* and wall A substantially as (shown) and for the purposes set forth.

12. In a retaining wall, the beam *i* attached to the brace *f* in combination with the ma-
139 sonry A, substantially as and for the purposes set forth.

13. In a retaining wall the combination of the metal frame work consisting of the longitudinal
Amd't. bars *a* and *i* and a series of *tapering* upright bents
Mar. 17, 1900. *and braces between said bents and the bars i* with a wall of masonry enclosing said frame work substantially as and for the purposes set forth.

14. In retaining walls, the brackets *h* attached to the brace *f* in combination with the masonry A for the purpose set forth.

15. In a retaining wall, the base *g* in combination
Apr. 17, 1900. with the upright *member e* tie *f* and masonry A, substantially as (shown) and described.

Substitute F, May 2, 1900.

(16. In retaining walls, the projections *m m m* on the rear of said wall in combination with the wall A and the retained material B substantially as and for the purposes set forth.)

Body of Office Letter of May 18, 1899.

The case has been examined.

The drawing is objected to by the draughtsman on account of the solid block. If desired the office will correct this free of charge.

The statement in lines 14-18, page 2 is not correct, as the outward thrust of the earth above the heel tends to cause the heel of the wall to press up and not down.

Claims 1, 2, 3, 4, 5, 7 and 13 are met by Jackson, 462,437, Nov. 3, 1891 (Masonry Cellars).

Claim 6 is met by Hyatt, 314,941, March 31, 1885 (Forming and preserving Channels).

Claim 9 is met by Buffington, 383,170, May 22, 1888, (Iron Structures, Buildings).

Claim 10. The combination in this claim is incomplete as it does not produce any unitary result. See Glidden vs. Copeland, 15 O. G. 920.

Claim 16 is met by Goodridge, 317,338, May 5, 1885, and Cheney, 591,949, Oct. 19, 1897 (Culverts).

Claims 1, 2, 3, 4, 5, 6, 7, 9, 10, 13 and 16 are rejected.

B. W. POND, *Ex.*

140 On March 5, 1900, Frank A. Bone appointed F. T. F. Johnson, his attorney for the further prosecution of the application.

Amendment of March 17, 1900.

Hon. Commissioner of Patents.

SIR: This case is amended as follows:

In the specification:

Page 1, lines 26 and 27, cancel "the bent at *y, z.*" and insert *bent* (on line *y-z*, Fig. 2).

Page 1, line 28, cancel "all of the various figures," and insert (the drawing).

Page 2, line 9, after "as" cancel "it."

Page 2, line 25, after "members" insert (*c-c*).

Page 3, line 19, after "The two angles" insert (*g*).

Page 3, line 30, after "This bar" insert (*a*).

Page 4, line 2, after "more" insert (may).

Page 4, line 4, cancel "upright" and insert (brace *f*).

Page 4, line 16, after "piles" insert (*a*).

Page 5, line 5, before "back" insert (heel or).

Claim 1, line 2, before "upright" insert (tapering).

Claim 2, line 2, before "upright" insert (tapering).

Claim 3, line 2, before "embedded" insert (braces).

Claim 4, line 2, after "within" insert (and connected with braces in the wall by suitable brace rods).

Claim 5, line 2, after "rods" insert (provided with enlarged ends and).

Claim 6, line 1, cancel "bents" and insert (tapering bents embodied in said wall).

Claim 6, line 3, cancel "shown above" and insert (described).

Claim 7, after "rods *k*" insert (provided with enlarged ends and embedded).

Claim 9, line 2, after "top," insert (angle rods *i* and braces *f* between said rods and said bents).

Claim 13, line 2, before "upright" insert (tapering).

Claim 13, line 3, before "with" insert and (braces between said bents and the bars *i*).

This case has been amended in view of the last Office letter and the reference therein cited. The claims as now amended
141 are thought to avoid conflict with the references and an allowance thereof is, therefore, asked.

Respectfully,

F. T. F. JOHNSON, *Atty.*

March 17, 1900.

Body of the Patent Office Action of April 5, 1900.

This case has been re-examined in view of the amendment filed March 17, 1900. Applicant should give permission to the office to correct the solid black on the drawing.

Claim 1 does not display any invention over Jackson of record. It

the everyday thing in iron work construction to diminish the section as the strain decreases, see Buffington.

Claim 3 is met by Jackson.

Claim 5 is substantially met by Jackson. The bars *b* in that patent are fair equivalent of applicant's "enlarged ends *s*."

Claims 10 and 16 are met by references previously cited.

Claims 1, 3, 5, 10 and 16 are rejected.

B. W. POND, *Ex.*

E. C. REYNOLDS,
3rd Asst. Exam.

Amendment of April 17, 1900.

Hon. Commissioner of Patents.

SIR: This case is amended as follows:

A. Page 2, at the end of line 29, add—(To each member at the rear thereof is riveted one or more T-shaped angle plates *b*, which extend, preferably, above and beyond the upright member *c*.)

Page 2, cancel line 30 and line 1 of page 3.
Page 3, line 2, cancel "angles" and insert (angle plates *b*).
Page 3, line 6, after "upright" insert (member).
Page 3, line 8, after "angles" insert (and at an angle thereto).
Page 3, line 9, after "masonry" insert (and prevent vertical sliding of the member).
Page 3, line 11, cancel "plate" and insert (member).
Page 3, line 13, cancel "upright" and insert (member).
Page 3, line 16, after "top of" insert (and secured to).
Page 3, line 19, cancel "angles" and insert (angle plates).
Page 3, line 19, cancel "plate" and insert (member).
Page 3, line 20, cancel "into" and insert (in).
Page 3, line 28, after "upright" insert (members).
Page 3, line 31, after "bent" insert (or members *c*).
Page 5, cancel lines 21 to 24 inclusive, and substitute:

B. (The T-shaped angle-plate *b*, a cross sections of which is shown in Figure 3, is secured to the rear side of the upright member *c* and is used on account of its stiffness and rigidity, and because the greatest mass of the metal is placed in the extreme back part of the wall where the greatest strain comes, and where it is of the most service.)

Cancel claims 1, 3, 5 and substitute therefor the following:

Amdt., May 2, 1900.

C. (1. The combination with a retaining wall having a heel, of a metal structure embedded *vertically* in said wall and

obliquely in said heel, (in such a manner) so that the weigh of the retained material upon the heel of the metal structur will operate to maintain the wall in vertical position.)

May 2, 1900.

D. (3. The combination with a retaining wall having *an inclined* (*a*) heel, of a metal structure embedded within said wall and heel, consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, in such a manner that the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in vertical position.)

E. (5. The combination with a retaining wall having a heel of a metal structure embedded within said wall and heel, consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof in an inclined direction, whereby the weight of the retained material upon the heel of the
143 metal structure will operate to maintain the wall in a vertical position, as set forth.)

Claim 2, line 2 after "bents" insert (or members).
Claim 2, line 5, cancel ("shown").
Claim 6, line 2 after "upright" insert (member).
Claim 8, line 2, after "upright" insert (member).
Claim 11, line 2, after "upright" insert (member).
Claim 11, line 3, cancel "shown".
Claim 15, line 2, after "upright" insert (member).
Claim 15, line 2, cancel "shown and".

This case has been amended in view of the last Office Letter and the reference therein cited. The claims are thought to avoid the references and an allowance thereof is asked.

Respectfully, F. T. F. JOHNSON, *Atty.*

(On back:) Serial No. 713,859. Paper No. 5. Amd't- A-E. Filed April 17, 1900. F. A. Bone. U. S. Patent Office, Apr. 17, 1900, Division IV.

Body of Patent Office Action of April 30, 1900.

This case has been re-examined in view of the amendment filed April 13, 1900.

The drawing is informal on account of the solid block.

Claims 1 and 3 are met by Jackson of record.

Claims 1, 3, 10 and 16 are rejected.

B. W. BOND, *Ex.*

E. C. REYNOLDS,
3rd Asst. Exam.

Amendment of May 2, 1900.

Hon Commissioner of Patents.

SIR: This case is hereby amended as follows:
Claim 1, line 2 after "embedded" insert (vertically).
Claim 1, line 2, after "and" insert (obliquely in said).
Claim 1, line 2, cancel "in such a manner" and insert (so).
Claim 3, line 1, before "heel" cancel "a" and substitute (an inclined).
Cancel claim 16 and substitute:

F. 144 (16. The combination with a retaining wall having a *a* heel and a toe at opposite sides thereof, said toe having an independent metal structure embedded therein, of a metal structure embedded within said wall and heel, said structure consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, so that the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in a vertical position.)

Add the following claim:

G. (17. The combination with a retaining wall having an inclined heel and toe at opposite sides thereof, of a metal structure embedded within said wall and heel, said structure consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, whereby by reason of the toe and the heel the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in a vertical position.)

The Office will please make the correction in the drawing as per Office letter of April 5, 1900.

This case is amended in view of the last Office letter and the reference Jackson. It is thought that the claims as now presented avoid the objections. The construction of Jackson's wall is not such as would overcome the lateral horizontal strain of the contained material by and through the downward pressure and weight of such material. In fact, the wall of Jackson would support itself as well without the metal structure contained therein as it does with it, with, perhaps, the exception that by the construction shown in Jackson the metal which projects into the floor would prevent the slipping of the wall at the base. There is nothing, however, in the construction shown by Jackson that would prevent or tend to prevent the splitting of the vertical wall from the horizontal floor portion except the weight of the superimposed wall, such as is had in every brick house as constructed today, i. e., the horizontal displacement of the masonry in the Jackson wall is prevented by the weight of the wall above. It

would, however be found that if the wall of Jackson were used merely as a retaining wall, and built say ten to fifteen feet high that it would push over, as there is nothing, so far as exhibited in the patent
145 whereby this lateral pressure would be overcome, except by the iron embedded in the vertical wall. It is apparent that this iron under a great strain would simply bend at the junction of the vertical wall with the floor and the wall be thrown out of plumb, and would fall. The claims of the applicant have been so drawn that the weight of the contained material becomes absolutely essential to the —, and should be allowed. An early and favorable action on the claims as presented is asked.

Respectfully,

F. T. F. JOHNSON, *Atty.*

Washington, D. C., May 2nd, 1900.

Body of Patent Office Action of May 17, 1900.

This case has been re-examined in view of the amendment filed May 2nd, 1900.

The offer to correct the drawing free of charge by removing the solid black, was made by the examiner through a misunderstanding of the draftsman's meaning, and will have to be withdrawn. The changes if made by the office will cost $1.00.

Claim 10 is finally rejected for reasons previously stated.

B. W. POND, *Ex.*

E. C. REYNOLDS,
3rd Asst. Exam.

(On back:) Serial No. 713,859. Paper No. 8. Second Rej. Dated May 17, 1900. F. A. Bone.

Amendment of May 16, 1901.

Hon. Commissioner of Patents.

SIR: This case is amended by canceling Claim 10, and substituting therefor the following:

C. (10. In a retained wall, the combination with the masonry thereof, of upright bents having their lower ends suitably anchored and braced, and provided with suitable angle plates and brackets, said angle plates and brackets being adapted to be so held in said masonry that any vertical or lateral
146 slipping or movement of said plates or brackets independent of the movement of the upright bents and the wall will be prevented.)

This case has been amended in view of the last Office letter. The claim as now presented is thought to be in condition for an allow-

ge and a favorable action thereon is therefore asked. The drawings ve been corrected to avoid the draftsman's objection.

Respectfully,

F. T. F. JOHNSON, *Attorney.*

Extract from Bone Abandoned Application.

Specification and Claims.

To all whom it may concern:

Be it known that I, Frank A. Bone, a citizen of the United States, siding at Lebanon, in the county of Warren and State of Ohio, ave invented a new and useful retaining wall, of which the follow- ng is a specification.

My invention relates to improvements in retaining walls of abut- ents of bridges, seawalls, banks of streams, embankments, dams, uts and such places as it is desired to retain earth or other material ermanently in place with its face at an angle nearer vertical than it ould naturally repose when exposed to the action of the elements f gravity.

The said invention consists of introducing into masonry of con- rete, stone or brick a frame work of steel or iron in such a way that he whole wall is so much strengthened that the volume of masonry ay be greatly reduced and yet the height, base and strength against verturning, bulging or settling will still be ample.

This object (stability with reduced volume) is further accom- lished by the peculiar shape of the cross section of the wall allow- ble, also in a yielding foundation by introducing a row of piles nder the toe of the wall.

The construction is shown in the accompanying drawings in which Fig. 1 represents a cross sectional view of my invention. Fig. 2 represents a sectional view along the line *w. x.* of figures 1 and 3. Fig. 3 represents a plan view of fig. 1 with the top cut off at line *y. z.* of said figure 1. Fig. 4 represents a section of he steel upright at *v. v.* of fig. 1. In all the various figures similar etters refer to corresponding parts throughout the several views.

In the form of wall shown, the base extends about equally to the ront and rear of the vertical part of the wall, but this may be varied o suit the circumstances: That is, the base with proper proportions f metal in the frame may be made to extend almost wholly to the ear or to the front of the vertical part of the wall without danger of s breaking off, the form shown in drawing being what might be alled an inverted T., while those suggested would be in form of an L. or reversed L.

A. represents the earth or other material to be retained in place f A' the earth on which the wall rests. B. represents the masonry.

It is evident a wall of the shapes mentioned is not so liable to be verturned from pressure of material behind it as would a wall of he same height and an area of section, but having a rectangular rapezoidal or triangular shaped section for it is impossible to obtain

as much base and height with a given amount of masonry, with these last named shapes as it is with those described above.

This wall also having more base and less weight, will rest more securely on a yielding foundation.

The retaining wall is preferably composed of cement concrete masonry, with a skeleton or frame work of steel or iron of peculiar construction hereinafter described.

Brick or stone masonry may however be used in place of concrete, or concrete backing may be used with brick or stone face.

The skeleton of steel consists of a number of upright bents composed of the base preferably of two angles *a*, *a*. To this base is riveted the upright *b*, composed preferably of a tapering plate *b*, and the angles *c*, *c*, and *m*, *m*, on each side. These angles are not simply to stiffen the member but are also intended as flanges which the masonry can act against so that there will be no liability of the masonry moving outward without the upright moving also. The angles *c*, *c*, are made heavier than *m*, *m*, as the most benefit is received from the material at the back part of the wall. There are also small angle brackets *d*, *d*, *d*, on both sides of the upright to prevent any liability of its sliding vertically in the concrete
148 at that part of the upright. The said upright is made tapering because the greatest strength is needed toward the bottom. *e*, is a brace composed preferably of a plate which acts in tension between the base *a*, and the upright *b*. The force of gravity which is exerted downward by the material resting on the back part of the base is carried by this brace up to the upright *b*, to keep said upright in position, that is to prevent its being pushed outward by the material back of the wall.

f, is a brace composed preferably of two angles and carries a compression stress from the upright *b*, to the base near the toe of the wall.

On top of the brace are riveted some small angle brackets *g*, *g*. These are for the purpose of giving the masonry a hold on the brace so that the vertical force downward in the masonry at that point may be carried to the toe of the wall.

These braces together with the steel base also strengthen the parts of the base which project in front of the vertical wall, against breaking off.

The bars *h*, *h*, preferably angles run horizontally through the length of the wall and are firmly fastened to the uprights *b*, at each intersection.

These bars not only act to hold the wall together and carry the stresses in the masonry to the bents, but also greatly strengthen the wall against overturning where the wall has horizontal angles or curves in it as is generally the case is bridge abutments.

For low walls but one of these horizontal bars is used, while two or more are used in higher walls.

In soft or yielding foundations a row of piles *i*, are placed along under the toe of the wall. With the *piles* driven to a firm foundation or with the toe of the wall resting on a firm foundation the wall in order to be overturned by a pressure in the rear, would have to

arm on the toe of the wall with a pivot near where the pile *i*. is located in the drawing.

In this case it is evident that the body of the wall together with the earth or other material resting on the back of the base will have to be lifted upward.

The shape of this wall, as mentioned above, is such that this tendency to be overturned by pressure on the back is overcome with a minimum amount of material in the wall. But this reduced amount of material in masonry must be reinforced by the introduction of a stronger material where the greatest stress comes.

149 I would remark here that steel and concrete masonry work together admirably, for their coefficients of expansion from effects of heat, are almost exactly the same. The concrete adheres with great tenacity to the steel protecting it absolutely from rust and corrosion.

With the earth pressing outward on the vertical part of the wall and downward on the back part of the base, it is evident that the internal stresses created in the wall will act to create tension in the rear and compression on the front or that the pressure outward results in an upward pull on the back and a downward push on the front part of the vertical wall.

Now ordinary good masonry of concrete brick or stone is as good a material as we could desire to resist the compression stress in the front, but with a wall as described above and shown in proportions of the drawings, the best of masonry would be deficient in strength in the back part and would be liable to crack open and the body of the wall break off and fall outward. I therefore place my steel in the extreme back part of the wall where the tension is greatest and where the steel will have the greatest effect being farthest from the neutral axis of the wall. The upright of steel or iron is however made stiff enough to resist any tendency of the wall to bulge that might occur in making a wall as thin as the one described.

The back part of the base or heel of the wall under the forces mentioned above, would be subject to tension in the upper portion, being greatest near the vertical part of the wall. I therefore put in a strong tie brace *e*. at this point. The greatest compression strain occurs at about the point indicated by *f*. I therefore reinforce the masonry at this place with the strut *f*.

k. is a stiff bar of steel resting on the flanges of the base *a*. and reaching from one bent to the next and is for the purpose of strengthening the concrete between the bents at that point and thus help carry the weight of the superimposed material to the base *a*.

In building my retaining wall the steel frame or skeleton is first erected in place, each intersection being fastened together with a sufficient number of rivets or bolts. The masonry is then built around the frame, completely covering it and protecting it from the elements.

I am aware that retaining walls have been constructed of concrete and steel but none to my knowledge have been supported on

150 their own base as in mine nor have any of them entirely enclosed the steel within the concrete.

Having thus described my invention, what I claim as new, and desire to secure by letters patent is

1. In retaining walls the combination with a wall of masonry, a series of upright bents imbedded within the interior of said masonry as near as practicable in a line of greatest tensile strain in said wall from the heel to the top, and having such connections and sections as to supply strength to resist such tensile strains substantially as described.

2. A retaining wall having a metal strengthened heel extending to the rear of the base upon which the retained material rests and acts by gravity to keep said wall in its normal position substantially as described.

3. A retaining wall having a toe extending to the front of the base, said toe being strengthened by the metal base *a*. and brace *f*. substantially shown and for the purpose set forth.

4. In a retaining wall a series of bents composed of the upright *b*. base *a*. and the tie brace *e*. in combination with the masonry B. substantially as shown and described.

5. In a retaining wall a series of bents composed of the upright *b*. base *a*. and braces *e*. and *f*. in combination with the masonry B. substantially as described.

6. In retaining walls a series of bents composed of the tapering upright *b*. having flanges *c*. and *m*. the tie brace *e*. the strut brace *f*. and the base *a* in combination with the masonry B. substantially as and for the purposes set forth.

7. In retaining walls the brackets *d d* attached to the upright *b*. in combination with the masonry B. substantially as and for the purposes set forth.

8. In retaining walls the brackets *g g* attached to the brace *f* in combination with the masonry B substantially as and for the purposes set forth

9. In a retaining wall the beam *k* resting on the flanges of the base *a* in combination with the masonry B substantially as and for the purpose set forth.

10. In a retaining wall the combination of the metal frame work consisting of the longitudinal bars *h* and a series of upright bents, with a wall of masonry enclosing said frame work substantially as and for the purpose set forth.

11. The combination of the retaining wall composed of masonry with a metal frame imbedded therein as above described,
151–2 with a row of piling under the toe of the wall substantially as shown and for the purpose set forth.

FRANK A. BONE.

Witnesses:

WM. CARSON.
E. B. PAULY.

Body of Patent Office Action of January 16, 1899.

This case has been examined.

In the brief description of fig. 4 the reference letter "*a*" should be "*a*." The first two lines of the last paragraph on page 2 do not make sense.

Claim 1 is met by Jackson, 462,437, Nov. 3, 1891 (Masonry Cellars) and Goodridge, 317,337, May 5, 1885 (Masonry Culverts).

Claim 2 is met by Jackson and Hyatt, 314,941 (Forming and Preserving Channels).

Claim 3 is met by Hyatt.

Claim 7 presents no essential novelty over Jackson or Goodridge.

Claim 10 is met by Jackson or Goodridge, it being common to place piles beneath the toe of walls or embankments, see Goodridge 331,127, Nov. 24, 1885 (Breakwaters).

Claims 1, 2, 3, 7 and 10 are rejected.

B. W. POND.

REYOLDS, *4th Asst.*

Letter of Abandonment of April 18, 1899.

To the Commissioner of Patents, Washington, D. C.

DEAR SIR: In the matter of my application for patent for Improvement in Retaining Walls, Serial No. 698,387, I hereby abandon the same as I do not desire to farther prosecute the application.

Signed at Lebanon, O., April 18th, 1899.

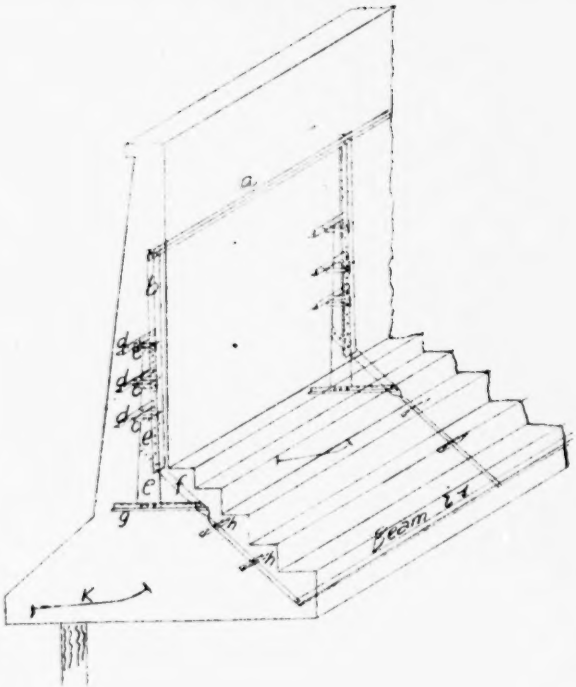
FRANK A. BONE.

Here follow

DIAGRAMS

marked pages 153 to 164,

inclusive.



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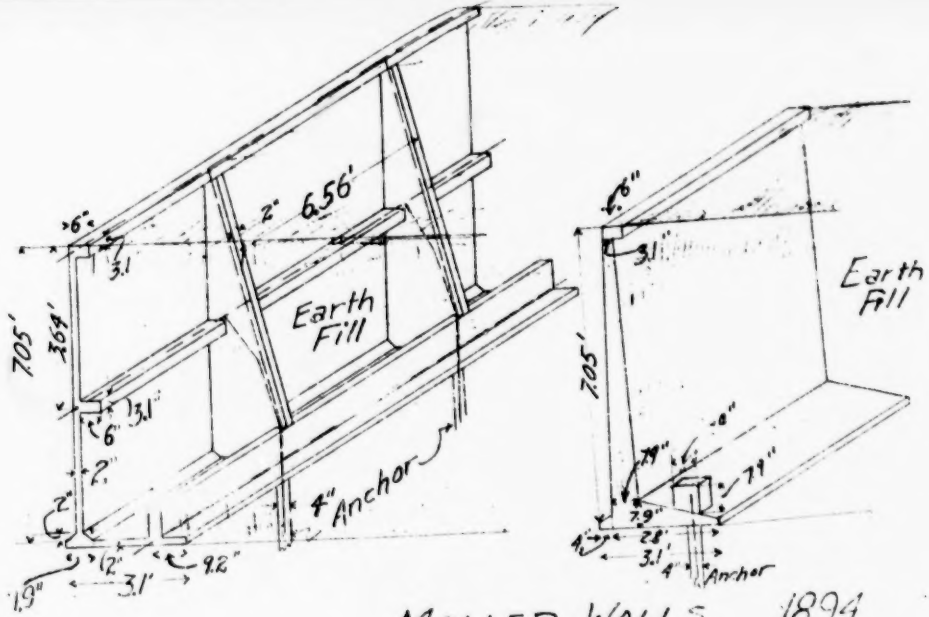
Marion Co. } ϕ153

BONE WALL ~ PATENT

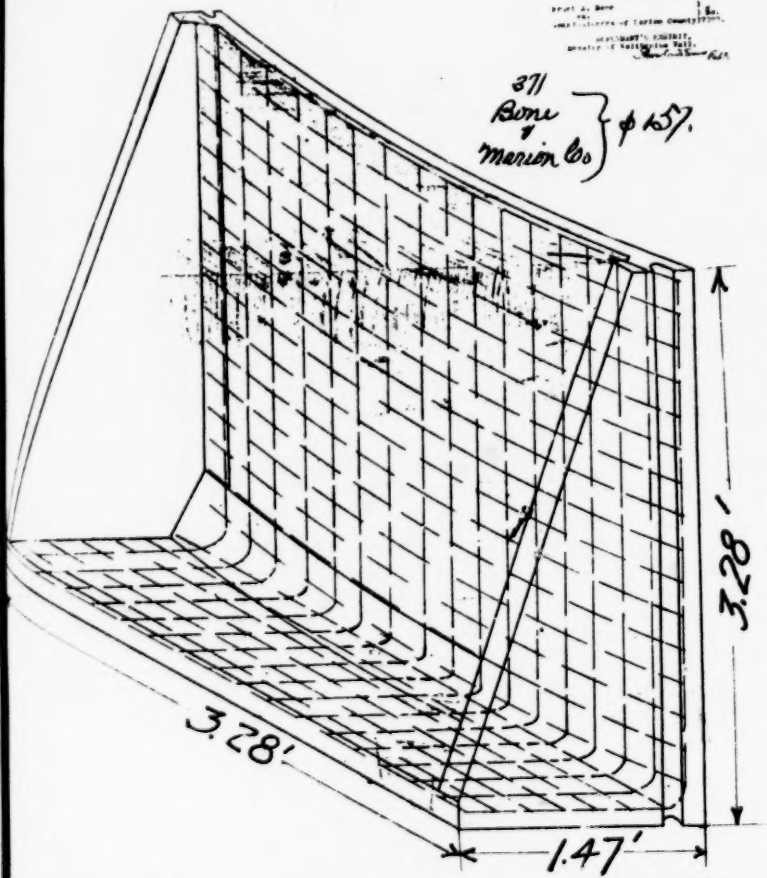


MOLLER WALLS 1894

Bauzeitung

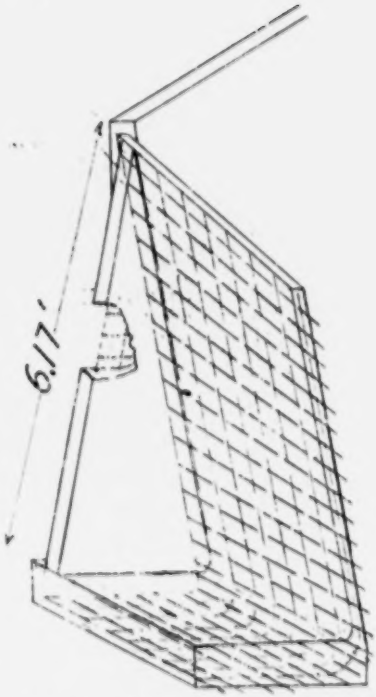
Bergu Maschinenbau p 155

371
Bone
Marion Co } $ 157.

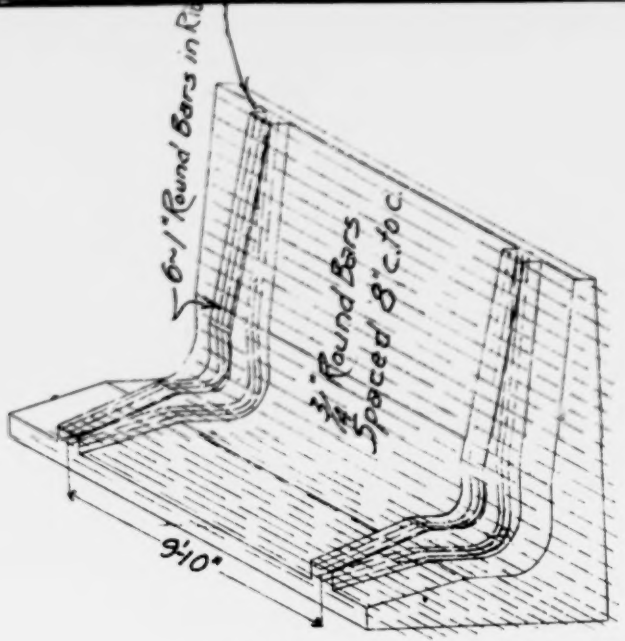


NOLTHENIUS WALL - 1895
Tijdschrift [Holland]

371
Rome
V
Marin Co } ϕ 139



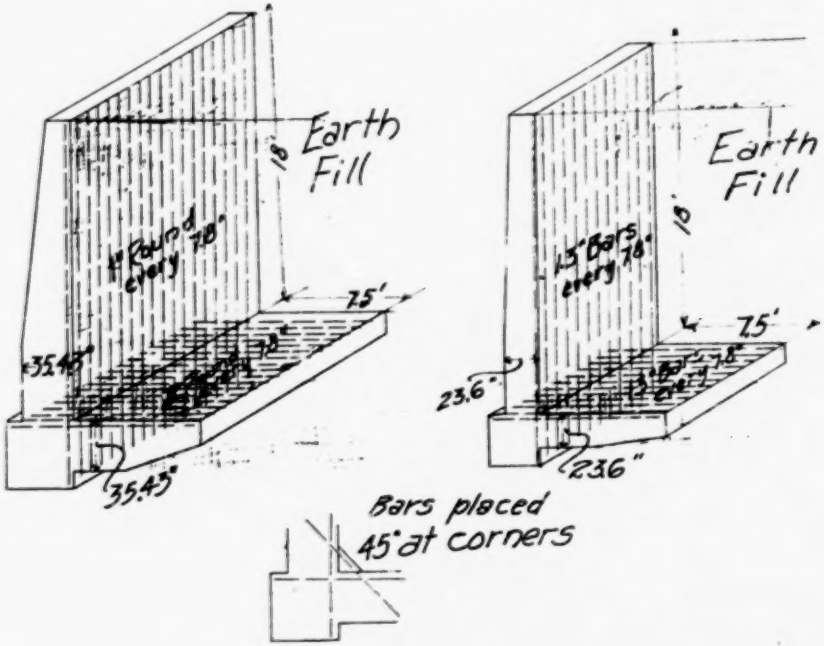
REHBEIN WALL ~ 1891
Ausgewählte Monier und
Beton Bauwerke



PLANAT WALL — 1894 - SEPT.
La Construction Moderne

PLANAT WALL — 1896 - SEPT.

La Construction Moderne



371 Barre & Montpelier Co

163

165 *Opinion of the Court.*

The Court: Well, I do not know, so far as the District Court is concerned, in an equity case, particularly in a patent case, that the District Judge occupies a position much above that of a master. If the district court decides the case, hears the witnesses, considers the evidence, then the whole thing is taken up to the Court of Appeals, heard de novo, and if the conclusions of the Court of Appeals coincide with those of the District Judge, there is a learned disquisition on the fact that the District Judge having seen the witnesses and heard the evidence, they will not disturb the finding. If, on the other hand, they conclude that the District Judge is wrong, there is no trouble about that.

Now, I started into the hearing of this case and when it was stated to me that the Circuit Court of Appeals of the Sixth Circuit had upheld this patent and had found infringement, I thought that the defendant would have a very serious time in attempting to get this court to differ from that court. I believe that if the question were doubtful, the court ought, in the interest of the proper administration of justice and the protection of the rights on both sides, if possible, agree with the court which had passed upon it before. But it is perfectly evident to my mind that the very foundation of the decision of the Circuit Court of Appeals, as well as the foundation of the decision of the District Court from which that case was appealed, was wrong; the very foundation of it was wrong. Gentlemen may go out from here with the absolute conviction that the court as constituted here did not understand this case, but I am very firmly convinced either that the matter was not fully presented to the District Judge in Cleveland, and that the record was not as fully made up in the Court of Appeals as it is here, or at least, that they did not understand it,—one or the other.

Now this man has set out here what his invention consists in. I notice that where a plaintiff has not a very clear ground to stand upon, it is pretty hard to get him to tell just what the invention consists of, and frequently I must go back to the patent to see what it means. Now, it is stated here:

"My invention relates to improvements in retaining walls for abutments of bridges, sea walls, banks of streams, embankments, cuts, dams, drydocks, and such places as it is desired to retain earth or other matter permanently in place with its face at an angle
166 nearer vertical than it would naturally repose when exposed to the action of the elements of gravity."

That is to what his invention relates.

"The said invention consists principally of introducing into masonry of concrete, stone or brick a frame-work of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base, and strength against overturning, bulging or settling will still be ample."

Then he says further:

"The object (stability with reduced volume) is further accomplished by the peculiar shape of the cross-section of the wall allowable."

Of course, that is true. Anybody could see that. Any boy who worked with mud could see that if you made the top of a wall three feet and the bottom two feet thick, it would not be as strong as if the proportions were reversed. So a man cannot predicate invention upon the peculiar shape of the cross-section of the wall.

Now, this case went before Judge Day, and what did he decide? Unfortunately for these gentlemen, the reasons are put in writing and I see the Judge's name is signed to it:

"The invention claimed relates to retaining walls or similar structures designed to retain earth or other matter in place with its face at an angle near vertical"—he means nearer vertical—"than it would naturally maintain as affected by the force of gravity and the action of the elements, and the invention consists in embedding in retaining walls of concrete, stone, or brick, a frame or skeleton of metal arranged in certain relations to the stresses which the wall is required to withstand."

Now, anybody who understands the reinforcement of concrete knows that from the very beginning of that art the metal was arranged in certain relation to the stresses that the wall was required to withstand. That ought to be so.

"The object is to obtain ample resistance to breaking, bulging, overturning or settling with a smaller volume of masonry than would be required for the ordinary gravity wall of equal strength and stability."

The object of every wall builder is to get the required or desired degree of strength with less masonry.

"The patent described and illustrates a concrete wall consisting of a thin vertical wall having an extended heel and toe rein-
167 forced in the upright portion by upright metallic members at the back part of the wall, and in the heel by metallic members extending obliquely along the upper part and in the toe by metallic members extending transversely along the bottom. The re-enforcing members are placed near the back face of the wall and heel and nearer the lower face of the toe. * * *

"This wall described by the patent uses the weight of the retained material to retain itself; while in the gravity well, which was old in the prior art, the resistance to overturning is the wall itself."

Then going on further:

"Considering the claims of the patent, and the testimony, I am of the opinion that Bone, the patentee, was the first to re-enforce the retaining wall, or similar wall of concrete or masonry in such a manner that the weight of the retained material would be utilized to impart through the re-enforcing members tensile resistance to the stem or vertical part of the wall, thereby fortifying this part of the wall against breaking strains."

And we now know in the light of the evidence in this case that Bone was not the first to re-enforce the retaining wall in such manner that the weight of the retained material would be utilized to impart

through the re-enforcing member tensile resistance. He was not the first person to re-enforce a retaining wall; he was not the first to conceive the idea of a re-enforced retaining wall which was so shaped and constructed that the weight of the earth on the heel of the wall would withstand the pressure of the dirt or the earth on the wall. He was not the first to do it. If there is anything that is absolutely demonstrated by the evidence in this case, he was not the first to do what Judge Day says he was the first to do, and upon that he predicates his opinion. Now it may be that upon the record before Judge Day, Bone was the first person to do that. So far as the record in this case is concerned, the absolute converse of that proposition has been demonstrated.

In the decision of that case in the Circuit Court of Appeals for the Sixth Circuit, the claims involved are the same as in this case, plus claim No. 2. There the claims were 1, 2, 3, 5, 16 and 17. Now, let us look at the decision:

"In the present state of the re-enforced concrete art, the impression [illegible] that there cannot be patentability in the structure [illegible] these claims; but the patent was issued upon an application filed in 1886, which was a renewal of an application in 1878, and Mr. Bone's idea is shown to have antedated his application."

How far it antedated it there is not anything here to show.

"We are thus carried back nearly twenty years. The record discloses nothing anticipating the substantial thought of the patent."

Now, what is the substantial thought of the patent?

"The said invention consists principally of introducing into masonry of concrete, stone or brick a frame-work of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base and strength against overturning, bulging or settling will still be ample."

The record in this case shows a number of things to anticipate that substantial thought. The court goes on, and evidently had in mind the distinction between a gravity wall and this wall:

"Masonry or concrete retaining walls were deep and heavy, and maintained by gravity in their resistance against a horizontal stress. There was no occasion for re-enforcement. Sustaining walls had been built of concrete with vertical re-enforcement; but they were maintained against side strain by crossties or beams, without which they might tip over. If the prior art had shown a structure intended for a retaining wall, and having a heel such that the weight of the earth thereon would tend to keep the wall erect, it might be difficult to find invention in merely adding the form of re-enforcement most suitable to create the desired tensile strength; but we find no such earlier structure."

Now the evidence in this case shows a number of such earlier structures and so the very foundation of this opinion is taken away by the evidence in this case, assuming that the decision was based upon the record as it was there.

On the application for a rehearing, where the court declined to

direct the court below to open the case to permit the defendant below to put in a certain German publication, after deciding that there was no satisfactory excuse for not producing the proof in due time, the court went on and said:

"While the new reference (if it passed the limits of mere suggestion or unsuccessful experiment) would be distinctly pertinent upon the issue of invention, and if properly proved in another case
169 should receive careful consideration, it is not so demonstrative of error in the result already reached as to require its reception."

So the court did not have before it the evidence either on the petition for a rehearing or on the original hearing, that this court has on the state of the prior art.

There is shown here beyond any question whatever retaining walls, anticipations of retaining walls, publications and descriptions of them which are of the cantilever type. One where the vertical bar is held in a vertical position by the weight of the earth upon the horizontal part of it, or the heel of it held by the weight of the earth which is to be retained; and those various retaining walls of that kind, operating in that way, are shown to be reenforced in various ways. So far as the shapes are concerned, they use various diversified shapes that are shown by this patentee. Take one of these exhibits which has the counterfort form. Take this model, for example. There is foreshadowed the very idea of the slant up. The character of the top there is the same, of it may be carried to a place not so near the top, and if this is a correct representation of the patent, the model here discloses it in detail.

When we come to the Stowell and Cunningham device, I cannot see how that is not a complete anticipation of everything this man did except it be that his patent is to be limited to the particular form which he shows for his framework. There is a retaining wall of concrete, with a framework of steel or iron, introduced into the concrete in such a way that the whole wall is much strengthened, and so much strengthened that the amount of material is much reduced. There is the model. How any court could understand this art, and understand what the patentee claims, and understand the Stowell and Cunningham patent and find that it does not anticipate, is beyond my comprehension. I assume that this Stowell and Cunningham patent was in some of these cases, but it is not necessary for me to hold that this patent is invalid in order to come to the conclusion, or reach the conclusion that I have to reach in this case. It may be valid, but if so, I do not think much can be said on that theory. If so, the only thing this man did was to devise a framework and embed it in concrete, and if you want to carry it forward, there is the method in which it should be embedded, in the sense that it was a framework put up first and the concrete poured in afterwards. Now, I think it is going a long way to assert that what the defendants did is an infringement of this patent on
170 either ground; and, inasmuch as I am a mere examining magistrate, and inasmuch as the defeated party usually

thinks that the trial court knows nothing about it and that he will go to a court that does understand it. I will dismiss this bill for want of equity. The record will show the bill dismissed for want of equity.

Decree of Jan. 26, 1916.

In the District Court of the United States for the District of Indiana, November Term, 1915, January 26, 1916.

In Equity.

No. 7293.

FRANK A. BONE

v.

COMMISSIONERS OF MARION COUNTY.

Before the Honorable Albert B. Anderson, Judge.

Decree.

Comes now the parties by their respective Solicitors, and this cause coming *in* to be finally heard by the Court and thereupon the Court having heard the evidence and the argument of counsel and being sufficiently advised in the premises, finds that the equity of this cause is with the defendant.

It is therefore ordered, adjudged and decreed by the Court, that the Bill of Complaint herein, be and the same is hereby dismissed for want of equity.

And it is further ordered, adjudged and decreed, by the Court, that the complainant do pay to the defendant its costs and charges herein, taxed at $—.

171 *Petition for Appeal.*

Filed Mar. 14, 1916.

In the District Court of the United States for the District of Indiana, November Term, 1915, March 14th, 1916.

In Equity.

No. 7293.

FRANK A. BONE

v.

COMMISSIONERS OF MARION COUNTY.

Before the Honorable Albert B. Anderson, Judge.

Comes now the complainant by Messrs. Ewald & Sharman, his Solicitors, and files his petition for appeal and assignment of errors herein, in the words and figures following, to-wit:

Petition for Appeal.

To the Hon. Albert B. Anderson, District Judge, United States District Court, District of Indiana:

The above named complainant feeling himself aggrieved by the decree made and entered in this cause on the 26th day of January, 1916, does hereby appeal from said decree to the Circuit Court of Appeals for the Seventh Circuit, for the reasons specified in the assignment of errors, which is filed herewith, and he prays that his appeal be allowed and that citation issue as provided by law, and that a transcript of the record, proceedings and papers upon which said decree was based, duly authenticated, may be sent to the United States Circuit Court of Appeals for the Seventh Circuit, sitting at Chicago, Illinois.

And your petitioner further prays that the proper order touching the security to be required of him to perfect his appeal be made.

EWALD & SHARMAN,
Solicitors for Complainant.

72 *Assignment of Errors.*

Filed Mar. 14, 1916.

In the United States District Court for the District of Indiana.

In Equity.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Assignment of Errors.

And now on this 14th day of March, 1916 comes the complainant by his solicitors, Ewald & Sharman and says that the decree entered in the above cause on the 26th day of January, 1916 is erroneous and unjust to complainant for the following reasons, to-wit:

First: The decree of the Court is contrary to the law and equity of the case:

Second: The decree of the Court is not sustained by the weight of the evidence in the case:

Third: The Court erred in refusing to hold the Bone patent #705,732 valid and infringed by defendants.

Fourth: The Court erred in refusing the relief prayed for in the Bill of Complaint in the cause.

Fifth: The Court erred in granting a decree for said defendants, whereas said decree should have adjudged the Bone patent #705,732 sued upon in said Bill of Complaint valid and that said defendants had infringed said letters patent.

Sixth: The Court erred in dismissing the Bill of Complaint in said case for want of equity.

Wherefore the complainant prays that said decree may be reversed by the Circuit Court of Appeals for the Seventh Circuit, and the District Court for the District of Indiana be instructed to enter such decree as is prayed for by said Bill of Complaint.

EWALD & SHARMAN,
Solicitor- for Complainant.

Order Allowing Appeal.

It is thereupon ordered by the Court that said appeal be, and the same is hereby, allowed upon the complainant filing a bond in thirty days in the sum of Five Hundred Dollars ($500.00), with surety to be approved by the Court.

173 *Appeal Bond.*

Filed Mar. 24, 1916.

In the District Court of the United States for the District of Indiana, November Term, 1915, March 24th, 1916.

In Equity.

No. 7293.

FRANK A. BONE

v.

COMMISSIONERS OF MARION COUNTY.

Before the Honorable Albert B. Anderson, Judge.

Comes now the complainant, by counsel, and files his appeal bond herein, in the penal sum of Five Hundred Dollars ($500.00) with National Surety Company of New York, N. Y. as Surety thereon, which bond is approved by the Court and is in the words and figures following, to-wit:

United States Circuit Court of Appeals for the Seventh Circuit.

No. 7293.

FRANK A. BONE

v.

COMMISSIONERS OF MARION COUNTY.

Know all Men by these Presents, That we Frank A. Bone, of Cincinnati, Ohio, as Principal, and National Surety Company, of New York City, New York, as Surety, are held and firmly bound unto the above named Commissioners of Marion County, in the sum of Five Hundred and no/100—($500.00)—Dollars to be paid to said Commissioners of Marion County to which payment, well and truly to be made, we bind ourselves jointly and severally, and our and each of our heirs, executors and administrators, jointly by these presents.

Sealed with our seals and dated this 20th day of March, 1916.

Whereas, the above named Frank A. Bone hath prosecuted an appeal to the United States Circuit Court of Appeals for the Seventh Circuit, to reverse the decree rendered in the above entitled suit, by the District Court of the United States for the District of Indiana:

Now, therefore, the condition of this obligation is, that if the
174 above named Frank A. Bone shall prosecute his said appeal to effect and answer all costs and damages that may be ad-

olged or awarded against him if he shall fail to make good his plea, hen this obligation to be void; otherwise in full force.

FRANK A. BONE. [SEAL.]

[SEAL.] NATIONAL SURETY COMPANY,

By L. C. BREUM,

Attorney in Fact. [SEAL.]

Sealed and delivered in presence of
H. Z. WEAVER.
S. M. FERRIS.

Taken and approved by me this 24th day of March 1916.
ALBERT B. ANDERSON, *Judge.*

Praecipe for Transcript of Record.

Praecipe.

To the Clerk:

You are requested to make a transcript of the record in the above ase to be filed in the United States Circuit Court of Appeals for the Seventh Circuit, pursuant to an appeal heretofore allowed in the bove entitled cause, and to include in such transcript of record the ollowing and no other papers or exhibits, to wit:

(1) Abstract of Bill of Complaint,
(2) Abstract of amended answer and amendments thereto,
(3) All stipulations about modes of proof and defendant's walls ncluding blue prints thereof and retention of exhibits,
(4) Abbreviated testimony of the witnesses,
(5) Deposition of Dr. Vos and copies of publications therein,
(6) Opinion of Court,
(7) Decree,
(8) Petition for Appeals,
(9) Assignment of Errors,
(10) Order fixing appeal bond,
(11) All other orders and pleadings in the case not above specified which you have record of in your office,
(12) Bond patent No. 705,732,
(13) Bond catalogue,
175 (14) Uncertified copies of the following patents;

	British patent to Brandon of 1874,	No.	2128,
U. S.	" " Alphonse De Mar	"	606,988,
U. S.	" " Francois Coignet	"	88,547,
U. S.	" " Adam Geisel,	"	597,281,
British	" " Hubner, of 1884,	"	11,021,
U. S.	patent to Peter H. Jackson,	No.	462,437,
U. S.	" " Franklin Haines,	"	508,308,
U. S.	" " Charles F. Stowell	"	629,477,
	and Andrew C. Cunningham,		
U. S.	patent to Guy B. Waite,	"	606,696,

(15) Copy of Judge Day's opinion from the record of the U. S. Sixth Circuit Court of Appeals.
(16) Copy of circular about Akron wall.
(17) Cuts and translations of the Planat publications, 1894 and 1896, the foreign language to be omitted.)
(18) Uncertified copy of cuts and translations of Bauzeitung article. (foreign language to be omitted).
(19) Extract of file wrapper contents of Stowell & Cunningham patent.
(20) Extract from the file wrapper contents of the Bone patent in suit.
(21) Extract from the file wrapper contents of the Bone early application filed December 5, 1898, Serial No. 698,387.
(22) Drawings of Bone wall, Bauzeitung wall, Nolthenius wall, Rehlein wall, Planat 1894 wall and Planat 1896 wall.

The foregoing praecipe is subject to the provisions of the attached stipulation.

Respectfully,

ARTHUR H. EWALD,
OLIVER W. SHARMAN,
Solicitors for Complainant.
V. H. LOCKWOOD,
Solicitors for Defendants.

176 *Stipulation.*

It is hereby stipulated by and between the counsel for the respective parties to the above-entitled cause, that the foregoing Praecipe contains the matter desired to be included in the printed record for the Court of Appeals; that in printing the publications in foreign languages, the translations shall be used instead of the foreign languages, the cuts in said exhibits, however, to be substantially as shown in the exhibits.

It is further stipulated that all exhibits in the case which shall not be actually included in said Praecipe shall be produced by the attorneys for the respective parties, at the trial of the cause on appeal, and left there for the use of the Court, until after the decision.

ARTHUR H. EWALD,
OLIVER W. SHARMAN,
Solicitors for Complainant.
V. H. LOCKWOOD,
Solicitors for Defendants.

(Here follow specifications and diagrams marked pages 177 to 242)

178

No. 705,732. Patented July 29, 1902.

F. A. BONE.

RETAINING WALL.

Application filed Apr. 21, 1900.

(No Model.)

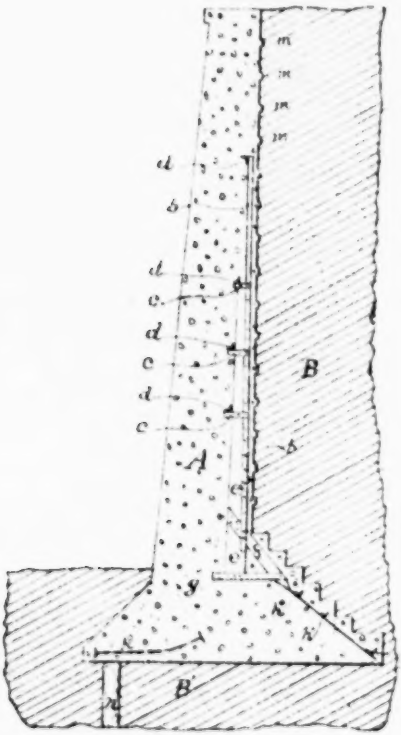


Fig. 1

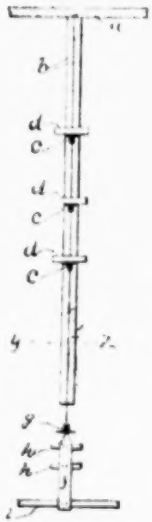


Fig. 2.

Fig. 3

Witnesses:
E. B. Pauly
R. B. Lambie

Frank A. Bone Inventor.

UNITED STATES PATENT OFFICE.

FRANK A. BONE, OF LEBANON, OHIO.

RETAINING-WALL.

SPECIFICATION forming part of Letters Patent No. 705,732, dated July 29, 1902.

Application filed April 21, 1899. Serial No. 713,859. (No model.)

To all whom it may concern:

Be it known that I, FRANK A. BONE, a citizen of the United States, residing at Lebanon, in the county of Warren and State of Ohio, have invented a new and useful Retaining-Wall, of which the following is a specification.

My invention relates to improvements in retaining-walls for abutments of bridges, sea-walls, banks of streams, embankments, cuts, dams, dry-docks, and such places as it is desired to retain earth or other matter permanently in place with its face at an angle nearer vertical than it would naturally repose when exposed to the action of the elements or gravity.

The said invention consists principally of introducing into masonry of concrete, stone, or brick a framework of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base, and strength against overturning, bulging, or settling will still be ample.

The object (stability with reduced volume) is further accomplished by the peculiar shape of the cross-section of the wall allowable.

The construction is shown in the accompanying drawings, in which—

Figure 1 represents a cross-sectional view of my invention. Fig. 2 represents a side view of one of the metal bents and connections, turned one-fourth around from its position in Fig. 1. Fig. 3 represents a cross-sectional view of the metal on line *y z*, Fig. 2.

In the drawings similar letters refer to corresponding parts throughout the several views.

In the form of wall shown the base extends somewhat more to the rear than to the front of the vertical part of the wall; but this may be varied to suit the circumstances—that is, the base with proper proportions of metal may be extended almost wholly to the rear or to the front of the vertical part without danger of its breaking off—the form shown in the drawings being what might be called an inverted T, while those suggested would be in the form of an L or reversed L.

A represents the masonry.

B represents the material retained; B', the earth on which the wall rests.

It is evident that a wall of the shapes mentioned is not so liable to be overturned from the pressure of material behind it as would a wall of the same height and area of section, but having a rectangular trapezoidal or triangular-shaped section, for it is impossible to obtain as much base and height with a given amount of masonry with these last-named shapes as it is with those described above. This wall also having more base and less weight will rest more securely on a soft or yielding foundation. The weight of the material resting on the heel acts, however, to cause said heel to press on the earth below and thus cause friction to prevent the wall from sliding outward.

The retaining-wall is preferably composed of cement concrete masonry with skeleton or framework of steel or iron located at the back parts, where the greatest tensile strain comes, and of other strengthening-rods of metal located at the lower part of the toe. Brick or stone masonry may, however, be used in place of concrete or a concrete backing may be used with a brick or stone face.

The skeleton consists of a number of upright members *e e*, placed at regular intervals in the wall, connected near the top by one or more horizontal bars *a* and at the bottom by the horizontal bars *i*. The upright members are the most essential part and consist of the plate *e*, made, preferably, tapering from bottom to top. To each member at the rear thereof is riveted one or more T-shaped angle-plates *b*, which extend, preferably, above and beyond the upright member *e*. These angle-plates *b* are not simply to stiffen and strengthen the members, but are also intended as flanges which the masonry can act against, so that there will be no liability of the masonry moving outward without the upright moving also. There are also small angle-brackets *c c c* on both sides of the upright member to prevent any liability of its sliding vertically in the masonry in that part of the wall. On top of these last-named angles and at an angle thereto are attached the short bars *d d d* to further anchor the member in the body of the masonry and prevent vertical sliding of the member. The brace *f* is composed, preferably, of a plate which acts in tension between the bar at *i* and the member *e*. The force of gravity which is exerted downward by the material resting on the back part of the base is carried by this brace up to the member *e* to keep said upright in position—that is, to prevent it, together with the wall, from being pushed out-

ward by the material back of said wall. The short angle-bars *h h* are placed on top of and secured to the brace *f* to assist in resisting any tendency of said brace to slide in the masonry. The two angle-plates *g*, attached to the bottom of the member *e*, are for anchoring the upright member in the base and also to stiffen the brace *f*.

It will be noticed that the metal in the upright member decreases from its junction with the brace *f* up to the bar *a*. This is done because the stress on this part of the wall decreases from the bottom to the top. It therefore would be a waste of material to make it the same size all the way up. The bar *a*, preferably an angle, runs horizontally through the length of the wall and is firmly fastened to the upright members at each intersection. This bar *a* not only acts to hold the wall together and carry the stresses in the masonry to the bents or members *e*, but it also greatly strengthens the wall against overturning where the wall has horizontal angles or curves in it, as is generally the case in bridge-abutments. For low walls but one of these horizontal bars is used, while two or more may be used for higher walls. The bar *i* extends from the bottom of one brace *f* to the bottom of the next and is intended to assist the masonry to carry the load imposed on top of it to the brace *f* and also to act as a flange on top of the tie *f*, that it may not slide through the masonry. It is not absolutely necessary that the bars *a* and *i* should run continuously through the wall as mentioned. They could be made to extend but a short distance on each side of the upright and would answer fairly well in a straight wall the purpose for which they are designed. The rod *k*, with an enlargement on each end, acts to strengthen the toe at the bottom where the greatest tension stress occurs. These rods are placed at proper intervals along the length of the wall, generally two or three feet apart.

In a soft or yielding foundation a row of piles *n* are placed along under the toe of the wall. With the piles driven to a firm foundation or with the toe of the wall resting on a firm foundation the wall in order to be overturned by a pressure in the rear would have to turn on the toe of the wall with a pivot near where the pile *n* is located in the drawings. In this case it is evident that the body of the wall, together with the earth or other material resting on the back of the base, will have to be lifted upward. Thus it can be seen that the shape of the wall as described is such that the tendency to be overturned by pressure on the back is overcome with a minimum amount of material in the wall; but this reduced amount of material in masonry must be reinforced by the introduction of a stronger material than masonry where the greatest tensile stress comes.

I would remark here that steel and concrete masonry work together admirably, for their coefficients of expansion from the effects of heat are almost exactly the same. The concrete adheres with great tenacity to the steel, protecting it absolutely from rust and corrosion.

With the earth pressing outward on the vertical part of the wall and downward on the heel or back part of the base it is evident that the internal stresses created within the wall will act to create tension in the rear, and compression in the front or the pressure outward results in an upward pull at the back and a downward push on the front part of the vertical part of the wall. Now ordinary good masonry of concrete, brick, or stone is as good a material as we could desire to resist the compressive strains on the front, but with a wall as described above and shown in the proportions of the drawings the best of masonry would be deficient in strength in the back part and would be liable to crack open and the body of the wall break off and fall outward. I therefore place my metal in the extreme back part of the wall, where the tension is greatest and where the metal will have the greatest effect being farthest from the neutral axis of the wall. The upright of metal is, however, made stiff enough to resist any tendency of the wall to bulge that might occur in making a wall as thin as the one described.

The T-shaped angle-plate *b*, a cross-section of which is shown in Fig. 3, is secured to the rear side of the upright member *e* and is used on account of its stiffness and rigidity and because the greatest mass of metal is placed in the extreme back part of the wall, where the greatest strain comes and where it is of the most service.

The back part of the base or the heel of the wall under the forces mentioned above would be subject to a tension in the upper portion. I therefore put in the tie-brace *f* at this point.

In building my retaining-wall the metal skeleton is first erected in place, each intersection being fastened together with a sufficient number of rivets or bolts. The masonry is then built around the frame, completely covering it and protecting it from the elements. The projections *m m m*, &c., on the back part of the wall run horizontally along the length of the wall and are for the purpose of increasing the sliding friction between the wall and the material retained, and thus assisting to keep said wall in its normal position. The retained material catches on the projections and creates considerable downward pressure on the back part of the wall as a resultant of the weight of the retained material. When the material retained is in a liquid state, I claim no advantage to be derived from the projections mentioned.

I am aware that retaining-walls have been constructed of concrete and steel, but none to my knowledge have been supported on their own base as mine, nor have any of them entirely inclosed the steel within the concrete, nor have any of them used the weight

of the material retained as a force to retain itself.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a retaining-wall having a heel, of a metal structure embedded vertically in said wall and obliquely in said heel, so that the weight of the retained material upon the heel of the metal structure will operate to retain the wall in vertical position.

2. In retaining-walls the combination with a wall of masonry, a series of tapering upright bents or members of metal braces embedded within the interior of said masonry at the back part, only, of the vertical portion and continuing down along the upper part of the heel of said wall to the back part thereof, substantially as and for the purposes set forth.

3. The combination with a retaining-wall having an inclined heel, of a metal structure embedded within said wall and heel, consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, in such a manner that the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in vertical position.

4. A retaining-wall having a heel (strengthened by metal within and connected with braces in the wall by suitable brace-rods) extending to the rear of the base, upon which the retained material rests and acts by gravity to keep said wall in its normal position, substantially as described.

5. The combination with a retaining-wall having a heel, of a metal structure embedded within said wall and heel, consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof in an inclined direction, whereby the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in a vertical position, as set forth.

6. In a retaining-wall, a series of tapering bents embodied in said wall composed of the upright member *e*, base *g* and tie-brace *f* in combination with the masonry substantially as described.

7. In a retaining-wall, a series of bents of metal in the back part of said wall extending down along the upper part of the heel, and a series of strengthening-rods *k* provided with enlarged ends and embedded in the lower part of the toe of said wall, in combination with the masonry of said wall, substantially as described.

8. In retaining-walls a series of bents composed of the tapering upright member *e* having flanges *b*, the tie-brace *f* and base-brackets *g* in combination with the masonry, substantially as and for the purpose set forth.

9. In retaining-walls, a series of upright bents tapering in size and strength from the base to the top, angle-rods *i* and braces *f* between said rods and said bents, in combination with the masonry, substantially as described and for the purpose set forth.

10. In a retaining-wall, the combination with the masonry thereof, of upright bents having their lower ends suitably anchored and braced, and provided with suitable angle-plates and brackets, said angle-plates and brackets being adapted to be so held in said masonry that any vertical or lateral slipping or movement of said plates or brackets independent of the movement of the upright bents and the wall will be prevented.

11. In retaining-walls the anchor-bars *a* attached to the bracket *c* in combination with the upright member *e* and wall A substantially as and for the purposes set forth.

12. In a retaining-wall, the beam *i* attached to the brace *f* in combination with the masonry A, substantially as and for the purposes set forth.

13. In a retaining-wall the combination of the metal framework consisting of the longitudinal bars *a* and *i* and a series of tapering upright bents and braces between said bents and the bars *i*, with a wall of masonry inclosing said framework substantially as and for the purposes set forth.

14. In retaining-walls, the brackets *h* attached to the brace *f* in combination with the masonry A for the purpose set forth.

15. In a retaining-wall, the base *g* in combination with the upright member *e*, tie *f* and masonry A, substantially as described.

16. The combination with a retaining-wall having a heel and a toe at opposite sides thereof, said toe having an independent metal structure embedded therein, of a metal structure embedded within said wall and heel, said structure consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, so that the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in a vertical position.

17. The combination with a retaining-wall having an inclined heel and a toe at opposite sides thereof, of a metal structure embedded within said wall and heel, said structure consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, whereby by reason of the toe and the heel the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in a vertical position.

Signed by me at Lebanon, Ohio, this 18th day of April, 1899.

FRANK A. BONE.

Witnesses:
E. B. PAULY,
R. B. CORWIN.

88,547

UNITED STATES PATENT OFFICE.

FRANÇOIS COIGNET, OF PARIS, FRANCE, ASSIGNOR TO L. MANGEON, OF NEW YORK CITY.

IMPROVEMENT IN MAKING ARTIFICIAL STONE, AND IN MONOLITHIC STRUCTURES.

Specification forming part of Letters Patent No. 88,547, dated April 6, 1869.

To all whom it may concern:

Be it known that I, FRANÇOIS COIGNET, of the city of Paris, in the department of the Seine and Empire of France, have invented certain Improvements in Artificial Stone, Monolithic Structures, and Artificial-Stone Articles; and I do hereby declare that the following is a full and exact description thereof.

This invention relates to the monolithic structures, or articles made of artificial-stone paste, agglomerated as described by me in my application for Letters Patent therefor; and the present improvement consists in the introduction into the body of the structure, or of the stone article, of double-headed nails, double T-pieces, clamps, hoops, scraps of twisted or irregular-shaped irons for the purpose of strengthening the same and giving it greater cohesive strength. The irons to be thus introduced may be arranged in such a manner as to interlace each other, so that by the combination of this metallic skeleton and of agglomerated artificial-stone paste the thickness of the walls or size of the articles may be considerably reduced and yet great strength be attained. Such, for example, would be the construction of a cylindrical web of small rod-iron or wire, upon and around which artificial-stone paste may be agglomerated so as to obtain water-pipes capable of resisting an interior pressure, which is so necessary in such pipes. Again, in the construction of troughs or water-vats angular-bent iron L-shaped pipes may with good effect be introduced in the body of the material to give greater strength to the angles and prevent the trough from spreading asunder at those points. The non-conductibility of the artificial stone made by my method allows it to be used to good purpose as a means of protecting and isolating telegraphic wires or conductors.

Claiming no novelty in the use of iron clamps or frame-work of metal in ordinary masonry or brick-work for strengthening the same,

What I do claim, and desire to secure by Letters Patent of the United States, is—

1. The combination of agglomerated artificial-stone paste with iron scraps of irregular shape, such as nails, double-headed nails or bolts, rings, hooks, clamps, wire, &c., substantially in the manner and for the purpose set forth.

2. The introduction, in the body of artificial stones, or in the body of artificial-stone monolithic structures, made of agglomerated artificial-stone paste, of skeletons, or metallic frame-work, linked or arranged so as to strengthen the same, substantially as specified.

3. The application of agglomerated artificial-stone paste to the protection and isolating of telegraphic wires.

FRANÇOIS COIGNET. [L. S.]

Witnesses:

EMILE BARRAULT,
17 *Boulevard St. Martin.*

S. BONARD,
17 *Boulevard St. Martin.*

=

[1] Here follow diagram marked p. 186

186

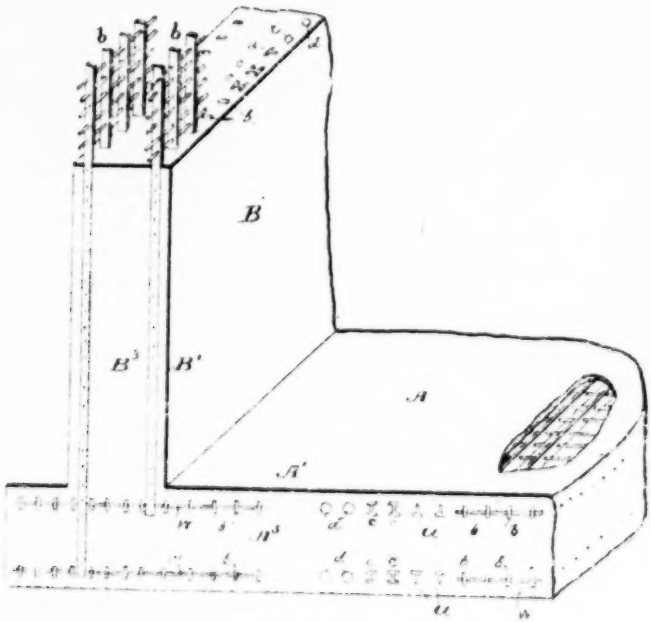
(No Model.)

P. H. JACKSON.

CONSTRUCTION OF FLOORS OR WALLS.

No. 462,437. Patented Nov. 3, 1891.

371
Bone
Marion Co } p186



WITNESSES:
J. Henry Kaiser.
Chas. E. Hunt.

INVENTOR:
Peter H. Jackson,
by R. S. Dyer & Co.
his attorneys

UNITED STATES PATENT OFFICE.

PETER H. JACKSON, OF SAN FRANCISCO, CALIFORNIA.

CONSTRUCTION OF FLOORS OR WALLS.

SPECIFICATION forming part of Letters Patent No. 462,437, dated November 3, 1891.

Application filed May 21, 1889. Serial No. 311,695. (No model.)

To all whom it may concern:

Be it known that I, PETER H. JACKSON, of San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in the Construction of Floors or Walls; and I hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to building basement, cellar, or vault constructions.

The object of the invention is to increase the stiffness and strength of walls or floors of buildings without increasing their thickness, so that a building will remain integral as in condition of original construction, will resist tensile and compressive strain, remain erect under the weakening effects of fire, and will withstand earthquake-shocks; furthermore, to produce a construction of vault or cellar adapted for building where the ground has been filled in or is otherwise soft and a poor foundation; furthermore, to produce a vault or cellar construction adapted for building where a larger surface than that inclosed by the walls of a building is required to support it, owing to the earth being soft or wet beneath and thus a poor resistant to the load above.

With these objects in view the invention resides in a building or similar structure comprising a wall or floor of two surface portions, each provided with metallic ties or small beams, whereby the wall or floor is stiffened and each portion made capable of withstanding strain; furthermore, in a construction for buildings comprising a foundation, cellar, or basement wall and a floor, both the wall and the floor being provided with metallic ties or beams joined, whereby the floor alone is made to form a firm, solid, and substantial foundation for a building.

I have illustrated the invention in the accompanying drawing, in which the figure represents a perspective view of a wall and basement-floor constructed in accordance with my invention, a portion of the concrete of the floor being broken away in order to illustrate the arrangement of the ties or beams.

In the drawing, A represents a floor of a cellar or basement, and B indicates one of the walls thereof. Both the wall and the floor are shown as made with two surface portions, (marked, respectively, B′ and A′,) built of hydraulic cement, concrete, or of brick, stone, or like material cemented together, and metallic ties *a*, *b*, *c*, *d*, and *e*, embedded slightly beneath both surfaces of the wall and the floor for the purpose of resisting tensile and compressive strain caused by transverse pressure in either direction. Between the surface portions of both the wall and the floor are the intermediate main courses of the wall and floor B and A, which are of brick, stone, or the like. If desired, I may interpose a stratum of asphaltum or other damp-resistant substance or material for the purpose of rendering the structure dry.

In the drawing I have shown the floor A as extending beyond the walls. This construction may be employed, if desired, though I do not wish to limit myself strictly thereto.

It is of advantage in positions where a larger surface than that inclosed by the walls is required to support it, owing to the earth being soft or wet beneath, thus affording a poor resistance to the great pressure of the weight of the building. It is advantageous that the ties or beams of the floor be attached to those of the wall, in order that the greatest strength and bracing-power may be produced.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

A foundation, cellar, or basement wall each surface portion of which is provided with metallic ties or beams, which make both the surface portions capable of resisting strain, the floor extending under the wall, the metallic ties or beams of the floor contiguous to those of the walls, whereby the floor alone is made to form a firm, solid, and substantial foundation for a building, substantially as herein described.

In testimony whereof I affix my signature in presence of two witnesses.

PETER H. JACKSON.

Witnesses:
E. H. THARP,
W. D. WALKER.

x Here follow diagram marked 1/90

190

(No Model.)

F. HAINES.

STREET CURBING.

No. 508,308. Patented Nov. 7, 1893.

Fig. 1.

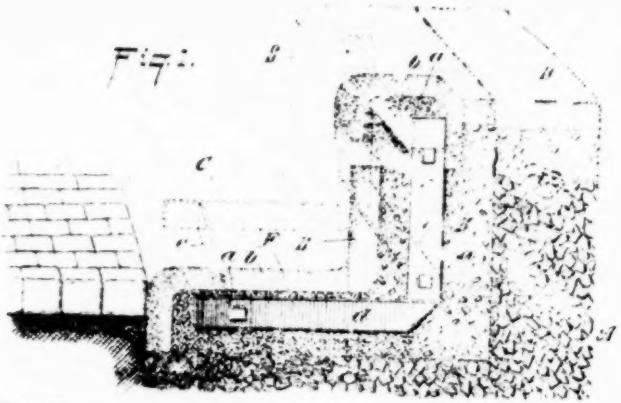


Fig. 2.

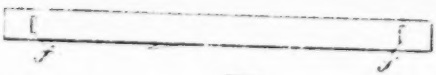


Fig. 5.

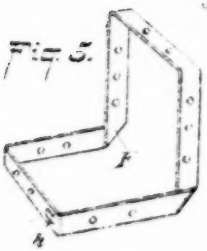


Fig. 3.

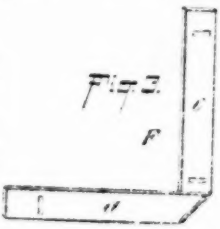
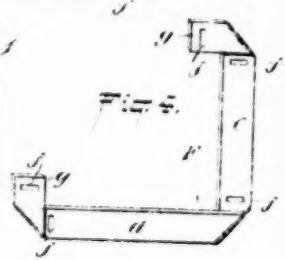


Fig. 4.



371
Bones
v.
Marion Co. } $190

WITNESSES:
William Goebel
F. J. Kennedy

INVENTOR
Franklin Haines
BY
Geo. Cook
ATTORNEY

UNITED STATES PATENT OFFICE.

FRANKLIN HAINES, OF YONKERS, NEW YORK.

STREET-CURBING.

SPECIFICATION forming part of Letters Patent No. 508,308, dated November 7, 1893.

Application filed June 28, 1892. Serial No. 438,547. (No specimens.)

To all whom it may concern:

Be it known that I, FRANKLIN HAINES, a citizen of the United States, and a resident of Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Street-Curbing, of which the following is a specification.

My invention relates to an improvement in curbs, and more particularly to those curbs made of artificial stone, the object being to provide a structure of this character which will be capable of withstanding the great strain or pressure imposed upon it, and which strain at times falls vertically upon that portion commonly known and referred to as the gutter stone, and sometimes laterally or horizontally against the curb proper, as when a cart or vehicle backs heavily against it, and with this and other ends in view, my invention consists in certain novel features of construction as will be hereinafter fully described and pointed out in the claims.

In the accompanying drawings, Figure 1 is a perspective view of a portion or section of curbing constructed in accordance with my invention, the upper part being partially broken away for the sake of illustration. Fig. 2 is a view of one of the end pieces of the binder before being bent into proper shape. Fig. 3 is a view of the same after bending. Fig. 4 is a similar view of the binder after the ends thereof have been given an additional bend for the purpose of extending them from one layer or course of material into the outer or finishing course. Fig. 5 is a view of a modification of the binder.

In constructing my improved curbing, I make use of any of the well known compositions or materials now employed for constructing artificial stone pavements, preferring to first form a foundation A therefor of broken stone, bricks, cinders, &c.; upon this foundation I build the curbing, consisting of the curb proper B, and the gutter stone C, formed either in one solid piece or separate. In the latter event, the curb proper B will first be formed, joining on one side the pavement D, if one there be, and formed on the opposite side with a flat face to which the gutter stone C is subsequently joined.

In constructing the curbing I prefer to employ two layers or courses of material, as for instance, the lower coarser layer *a* of gravel, crushed rock, cement, &c., and a finer upper or top layer *b* of cement, sand, crushed granite, &c. Embedded in the material is a binder constructed preferably of end pieces F shaped or bent as shown in Fig. 3, and formed from a metal plate or strip as shown in Fig. 2, the strip being bent over upon itself to form a vertical arm *c*, to extend up into the curb proper B, and a horizontal arm *d* to extend into the gutter stone C. By thus bending the metal, the edges of the arms *c* and *d* will be presented to the outer surface of the curb, in which direction the greatest strain falls thereon, thereby utilizing the greatest strength of the metal. The end pieces F of the binder are connected by the horizontal pieces or strips *e*, the ends of the latter extending through openings *f* formed in the pieces F for their reception, and bent down to lock or fasten them. These horizontal pieces *e* may be arranged either flatwise, or on edge, in accordance with the position or location of the curbing and in accordance with the probable direction of the greatest strain which they are to withstand or overcome either through pressure or strain upon the structure from the outside, or from the inherent tendency of the material to crack or separate, or otherwise, those in the drawings being arranged or placed on edge similar to the end pieces. If desired, the ends of the end pieces F may also be bent as shown at *g* in Fig. 4, the purpose and effect of which are to extend said ends *g* from the lower layer or course of material *a* into the top course *b* for the purpose of allowing said ends and cross pieces to assist in binding the two layers of material together more securely than would otherwise be the case. If desired the metal composing the binder may be perforated, as shown in Fig. 5, to allow of the cement or other material to enter and pass through it, and thereby securely hold the binder in place.

While I prefer to use the construction of binder above described, I do not limit my invention thereto, as other forms or constructions of binders may be utilized with good effects, as for instance, the binder may be constructed of one long strip of metal prop-

erly bent as shown in Fig. 5, the ends being locked as at *h*, instead of having the cross-pieces *c* made separate as shown in Fig. 1.

Although I have shown in the drawings the binder completely embedded in one section of curbing, it will be obvious that it may be of sufficient dimensions to extend from one section into another, and if desired from the curbing into the pavement to bind them together, as will be readily understood by those skilled in the art without further illustration, or further detail description.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A combined curb and gutter having embedded therein a flat metallic bar with its greatest width in a vertical plane transversely of the gutter and with the portion of the bar within the curb folded upon itself to stand in a vertical position within the curb portion, the bar being entirely embedded within the integral curb and gutter.

2. A combined curb and gutter having flat strengthening bars with the two ends bent at right angles to each other; each portion extending with its flat faces in a vertical plane across the gutter and curb and entirely embedded therein, substantially as set forth.

Signed at New York, in the county of New York and state of New York, this 22d day of June, A. D. 1892.

FRANKLIN HAINES.

Witnesses:
B. P. STRATTON,
WILLIAM GOEBEL.

At Here follow plan, sworn marked 1.

194

(No Model.)

A. GEISEL.

CONCRETE BRIDGE.

No. 597,281. Patented Jan. 11, 1898.

Fig. 1.

Fig. 2.

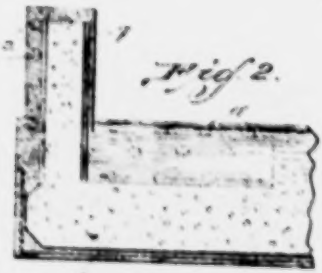
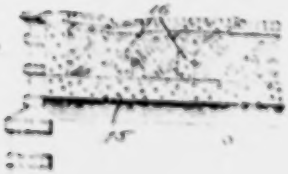


Fig. 3.



Witnesses
J. Gwill.

Inventor
Adam Geisel.

UNITED STATES PATENT OFFICE.

ADAM GEISEL, OF ST. LOUIS, MISSOURI.

CONCRETE BRIDGE.

SPECIFICATION forming part of Letters Patent No. 597,281, dated January 11, 1898.

Original application filed March 23, 1896, Serial No. 584,439. Divided and this application filed August 31, 1896. Renewed October 23, 1897. Serial No. 655,370. (No model.)

To all whom it may concern:

Be it known that I, ADAM GEISEL, of the city of St. Louis, State of Missouri, have invented certain new and useful Improvements in Concrete Bridges, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part hereof.

My invention relates to concrete arch-bridges; and it consists in the novel construction, combination, and arrangement of parts hereinafter shown, described, and claimed.

This application is supplementary to and should be read in connection with my application filed March 23, 1896, and serially numbered 584,439.

Figure 1 is a longitudinal sectional view of a bridge constructed in accordance with my invention. Fig. 2 is a horizontal sectional view on the line 2 2 of Fig. 1, and Fig. 3 is a vertical transverse sectional view on the line 3 3 of Fig. 1.

Referring by numerals to the accompanying drawings, the water 1 of the river rests on the bed 2 between the banks 3 and 4. In each of the banks 3 and 4 an excavation is made for the abutments 5 and 6 and the wing-walls 7, 8, 9, and 10 of the bridge. Piles 11 and 12 are sunk in these excavations until a solid foundation is reached. The upper ends of these piles are sawed off on a horizontal line about one foot above the bottom of the excavation. The ground plan of the abutments and wing-walls is shown in Fig. 3, the piling being shown in dotted lines.

After the piles have been driven and sawed off the excavations are cleaned out to the virgin earth. A layer of concrete about one foot in thickness is then placed in the excavation and thoroughly rammed around the heads of the piles. Similar layers of concrete are placed one on top of the other in the excavations until the abutments and wing-walls are of the desired height. Each layer is thoroughly sprinkled with water before another is added in order to form a thorough bond between the layers. When completed, the whole mass of each abutment and its wing-walls is a solid body of concrete. When the abutments and wing-walls get above the surface of the ground, suitable false work is erected to mold said abutments and wing-walls into the desired shape. After the concrete-work is finished the false work is left in position about three days or until the concrete has become sufficiently hardened to stand.

On the facing-walls of the abutments 5 and 6 are surfaces 13 and 14, forming the skew-backs, upon which the ends of the arch 15 are seated, the lines of said surfaces corresponding to the radial lines of the arch. The arch is in three pieces when the bridge is complete and consists of the two sides 15^a and 15^b and the keystone 15^c.

A layer of lead or asphalt 18 is inserted between each end of the arch and the skew-backs, and a similar layer is inserted on each side of the keystone. The layers 18 should be at least an inch thick.

The side pieces 15^a and 15^b are each constructed in five sections 15^d, 15^e, 15^f, 15^g, 15^h, 15^i, 15^j, 15^k, and 15^l. In constructing the arch I work from each end toward the center. The end section is cast, and before it has time to set the next section is cast and a bond forms between them, and so on until the pieces 15^a and 15^b are complete. At the boundary-line between the second and third sections from the outer ends of the pieces 15^a and 15^b the arch is between thirty-five and forty per cent. thicker than at the inner ends of said pieces and about ten per cent. thicker than at the outer ends. After placing a layer 18 of lead or asphalt against the upper end of the side pieces of the arch the keystone 15^c is then cast in position between said layers 18.

The center of the arch should be elevated slightly above a true center (about one inch to forty feet) in order that it may form a true arc of a circle after the bridge is completed and settled. The false work used in casting the arch should be left in position about twenty days after the arch is closed or long enough to allow the concrete to set.

I omit the usual haunchings on top of the arch and in their place I insert concrete walls 16 in the form of right-angled triangles. The short side of the triangle rests against the vertical face of the abutment and the hypotenuse rests upon the upper surface of the arch, thus bringing the long side of the right-angle

in a horizontal plane for the purpose of forming ribs to support the superstructure of the bridge. Similar walls 17 join with the wing-walls and the edges of the arch. There is no bond between the walls 16 and 17 and the arch. The space between these walls is filled with clean clay and rammed solid, after which the sidewalks and road-bed are laid in the usual way.

The distinguishing feature of my concrete arch-bridge is the joints in the arch and the substitution of the walls 16 and 17 for the usual haunchings, thus leaving the pieces of the arch free to expand or contract without cracking or breaking the arch and will also allow a settlement of the support of the arch without cracking the arch.

Where it is desired to build a bridge using a span or spans of from fifty to one hundred feet in length, the form of arch just described and shown in detail in Fig. 1 is sufficient and will prove very strong and durable.

The layers of lead or asphalt between the ends of the arch and the abutments form a joint between the arch and the abutments, which allows of sufficient action caused by expansion or contraction without cramping the parts of the arch and cracking or breaking the arch and abutments.

Within reasonable limits a layer of lead or asphalt when securely confined within the prescribed limits and subjected to great pressure will gradually change its form as the relative position or point of the greatest pressure changes. Within reasonable limits a layer of lead or asphalt resembles a pneumatic or hydraulic cushion in this quality of changing its shape to conform to the change of the conditions to which it is subjected. In warm weather when the haunches of the bridge expand the center of the arch will raise and the greatest pressure will be thrown upon the upper edges of the layers of asphalt or lead which are between the lower ends of the haunches and the skewbacks, and said upper edges will be compressed to some extent, and the material which is pressed out of said upper edges will pass downwardly and expand the lower edges of said layers, thus tending to keep the shape of the layer in conformity with the shape of the space which it occupies between the haunches and the skewbacks, and when the weather becomes cold again the haunches will contract, the center of the arch will be lowered, and the pressure will be removed from the upper edges of the layers of asphalt or lead and transferred to the lower edges of said layers, and the form of said layers will again change to suit the new conditions.

Thus it will be seen that by adopting my invention a concrete arch-bridge may be built having spans from fifty to one hundred feet in length which could not be done by any known process.

A complete concrete arch constructed in accordance with my invention herein described comprises three pieces and four joints. Each of the three pieces are cast in position, as heretofore suggested. In making these castings the section to be constructed is subdivided to suit the exigencies of the case. After work commences on one of these subdivisions that subdivision must be finished before the work is discontinued for the noon hour or for the night in order that there may be no divisions or cracks in the subdivision caused by the hardening of one part of the concrete before the next part is added. When the subdivision is completed, the templets in which the subdivision has been cast are left in position until the workmen are ready to begin the next subdivision. Then the templets are removed and the exposed surface of the completed subdivision to which it is proposed to join the new subdivision is thoroughly scratched with an iron brush and cleaned off with water, and a thick coat of mortar is spread all over said surface in order to prepare it for taking a bond with the completed subdivision, and this process is repeated until the entire section is completed.

In constructing the arch as her 'nbefore described I use concrete prepared as follows: Take one part of Portland cement, three parts of sand, and five parts of Macadam by measurement. Mix the sand and cement thoroughly together while dry. Then add a good sprinkling of water. Mix again until a stiff mortar is formed. Then spread the Macadam all over the mortar and turn the whole mass over three or more times and until the spawls are all covered with mortar. Then place the concrete so formed immediately in position and ram the same until the water flushes to the surface, after which the concrete is not to be disturbed. In order not to disturb the newly-made subdivision of the section by expansion of the false work from the moisture or dampness of the fresh concrete which is to form the next adjacent subdivision, the false work is thoroughly soaked for at least two days before the concrete-work commences, and then the sheeting of the false work is covered with waterproof paper, so that no additional moisture can come in contact with said false work.

An arch consisting of only three members constructed in accordance with my invention is strong enough to carry almost any weight, and supplemental haunches, which are a matter of necessity for either stone or brick arches, are not required in my bridge. This omission takes a large weight off of the foundations of the bridge, or, in other words, the foundations for an arch of my construction do not need to be near as heavy as for the old-style stone and iron arch.

In the place of the usual supplemental haunches I make the arch thicker at the breaking-point, which is about one-third of the length of the span from the skewbacks, and from the breaking-point the segments of the arch taper both ways, being the thinnest at the point next the keystone. The walls 16

are not a necessary part of the arch, but may be inserted or left out, as desired. When inserted, these walls form a convenient and effective support for the roadway, sidewalks, or whatever superstructure there may be above the arch.

I claim—

1. A concrete bridge, consisting of abutments, skewbacks formed upon said abutments, voussoirs of lead or asphalt upon said skewbacks, and voussoirs bonded together inserted between said voussoirs of lead or asphalt, substantially as specified.

2. A concrete bridge, consisting of abutments, skewbacks formed upon said abutments, voussoirs of lead or asphalt resting upon said skewbacks, voussoirs of concrete bonded together resting upon said voussoirs of lead or asphalt, voussoirs of lead or asphalt against the inner ends of said voussoirs of concrete, and a keystone between the last-mentioned voussoirs of lead or asphalt substantially as specified.

3. A concrete bridge, consisting of abutments, skewbacks formed upon said abutments, voussoirs of lead or asphalt resting upon said skewbacks, voussoirs of concrete bonded together resting upon said voussoirs of lead or asphalt, voussoirs of lead or asphalt against the inner ends of said voussoirs of concrete, a keystone between the last-mentioned voussoirs of lead and asphalt, and walls on top of said voussoirs, said walls being unbonded to said voussoirs and to said abutments, substantially as specified.

In testimony whereof I affix my signature in presence of two witnesses.

ADAM GEISEL.

Witnesses:
E. E. LONGAN,
MAUD GRIFFIN.

x(Here follow diagram marked p. 200

200

371 Bonds & Mortgages $200

No. 606,696. Patented July 5, 1898.

G. R. WAITE.

BEAM CONSTRUCTION FOR BUILDINGS.

(No Model.) (Application filed Mar. 12, 1897.)

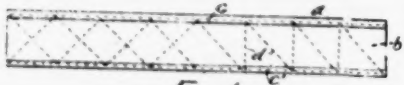


Fig 1

Fig 2

Fig 6

Fig 8

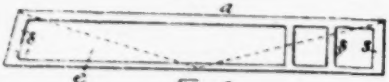


Fig 3

Fig 4

Fig 7

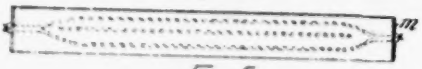


Fig 5

Fig 11

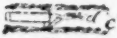


Fig 9

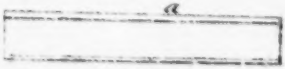


Fig 15

Fig 16

Fig 10

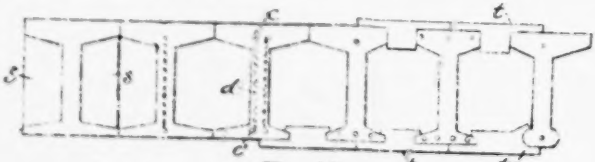


Fig 12

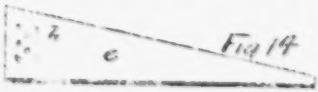
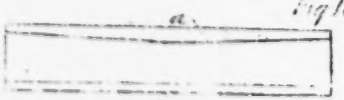


Fig 14

Fig 13



Fig

Witnesses:

Chas. Inc. w. Phillips

[illegible]

Geo. B. Waite

Inventor

UNITED STATES PATENT OFFICE.

GUY B. WAITE, OF HOBOKEN, NEW JERSEY.

BEAM CONSTRUCTION FOR BUILDINGS.

SPECIFICATION forming part of Letters Patent No. 606,696, dated July 5, 1898.

Application filed March 12, 1897. Serial No. 627,103. (No model.)

To all whom it may concern:

Be it known that I, GUY BENNETT WAITE, a citizen of the United States, residing at Hoboken, in the county of Hudson and State of New Jersey, have invented a new and useful Construction, of which the following is a specification.

My invention relates to a composite beam or girder to be used in building construction, which beam or girder is to be composed of two or more different kinds of materials united together to form one solid mass. One of the materials composing the beam or girder is some metal having high values for resisting stresses, and the other material or materials are substances capable of being applied to these metallic parts and forming both protecting and strengthening members to the beam.

The objects of this invention are to obtain a beam which is protected against oxidation and destruction by heat and to permit the smallest possible sections of metallic materials to be used in proportioning every part of the beam or girder throughout its entire length to exactly take the stresses imposed when the beam or girder is loaded.

The material which surrounds the metallic web and chord members of the beam or girder stiffens these members and enables the smallest sections to withstand compressive stresses and the tendency to buckle; also, to a greater or less extent the former material composes the main compressive members to the beam or girder, the main shearing and tensional stresses being taken by the metallic members. The beam is so made that it can be manufactured and finished in a factory ready for use in a building or in a foundation. The beam or girder is preferably made with a section which gives the maximum of strength compared with the weight of the beam—*i. e.*, I-shaped sections.

All parts of the beam can be tied together by a webwork of metallic members, which serve to prevent the breaking of the outer materials composing the beam and if such parts should become broken to prevent them from becoming separated and useless as compression members.

The construction of my beam or girder is illustrated in the accompanying drawings, which—

Figure 1 is a side elevation, and Fig. 2 is an end view, of a typical beam or girder.

c c' are respectively the upper and the lower metallic chords.

d are the metallic counter and web members, which connect with the top and the bottom metallic chords of the beam.

c', Fig. 1, is for the purpose of resisting the tensional stresses in the lower flange of the beam and will have the greatest strength at the center of the beam when the beam is to be loaded with a uniformly-distributed load and will diminish in strength toward the ends of the beam.

Members *d* in Fig. 1 are principally for purposes of conveying the shearing stresses to which the beam will be subjected and will be smallest in a beam intended for a uniformly-distributed load at the center of the beam and will gradually increase in strength toward its ends.

c' in Fig. 1 is intended to carry but a small proportion of the compression in the upper flange of the beam and is used mainly for tying the beam together and for distributing the stresses to members *d* and to the main part of the flange *a*, Fig. 1.

a, Fig. 1, is a composition which may be formed of a concrete, of a strong cement-mortar, a composition of clay, of plaster-of-paris, or of any similar substance capable of uniting with the metallic parts and forming one continuous solid tile.

As shown in Fig. 17, the flange *a*, Fig. 1, can be proportioned to exactly take the stresses throughout its entire length by increasing or decreasing the sectional area—*i. e.*, increasing or decreasing the thickness of the flange to correspond with the flange stresses.

The part *b*, Fig. 1, composing a part of the web of the beam and the external covering of the lower flange, is of substances similar to that described for *a*, Fig. 1. In some cases where the loads to be carried by the beam are very small and the parts *b* and *a*, Figs. 1 and 2, are ample to carry the entire stresses coming on the beam in those parts the metallic members *c* and *d*, Figs. 1 and 2, may be entirely omitted and metallic cord *c'*, Fig. 1,

receive the tensional stresses directly from *b*, Figs. 1 and 2. It is, however, desirable to use light metallic members *c* and *d*, Figs. 1 and 2, even when the material composing *a* and *b* are alone sufficient to distribute the strains coming in those parts for the purposes of insuring a perfect tie to the finished beam and to prevent the exterior parts from becoming broken when severely used.

Fig. 11 shows the form of a section with the lower flange omitted. A solid square or rectangular section could be used in place of the sections here shown, but would add considerable weight to the beam without materially increasing its strength.

Fig. 3 is a side elevation, and Fig. 4 is an end view, of a beam similar in construction to Figs. 1 and 2, except that a continuous metallic web *e* (shown in Fig. 14) with perforations or roughened surface *h* over its entire area is used instead of metallic members *d*, Figs. 1 and 2.

In Fig. 3, *e* is shown lowest in section at center of the beam, gradually increasing in height toward ends, which is thus proportioned to take the shear for a uniformly-distributed load on the beam.

S, Figs. 3 and 4, show ribs in the exterior surfaces of the beam toward the end where the shear on the beam is greatest, which is for the purpose of lending increased stiffness to the web *b* of the beam when it is deemed necessary.

Fig. 5 is a view looking upward at the lower flange of a beam having separate metallic tension members, showing the increase of these members from the ends of the beam toward the center, where they are greatest.

m, Fig. 5, shows a metallic washer or plate at the end of a beam, through which cords *c* and *c'*, Fig. 1, may extend and be made fast when desired.

Figs. 6 and 7 show side elevations, Figs. 8 and 9 show top views, and Fig. 10 shows end views, respectively, of metallic members shown in Fig. 1 and 2, where like letters designate similar parts.

In Figs. 6, 7, 8, 9, and 10 the metallic parts are generally represented as made up of twisted wire or twisted bars to give the roughness of surface necessary for the exterior material composing the beam to adhere to; but this character of metal is not strictly necessary, as any metallic surfaces which are made sufficiently rough will answer the purposes. The connections between members *c* and *c'* and members *d* are shown as a simple twisting of the parts composing *d* through an eye or loop in *c* or *c'*, which connection would not be sufficient if it were not for the solid exterior filling *b*, Fig. 2, which connects and maintains all parts in a rigid position. It is evident that any of the various means employed for connecting metallic members together may be used in connecting *d* with *c* and *c'*.

Fig. 12 shows various sections of beams, previously described, placed close together side by side, as would be used to form a continuous floor or foundation.

f, Fig. 12, shows means for applying an extra covering to the flanges of these beams when such covering is desirable.

Fig. 13 shows a continuous metallic web and flange *e*, bent so as to form a mold to receive the other composition forming beam, the lower metallic flange being strengthened by members *w*. The metallic web may continue the full length of beam with the same size section, as shown in Fig. 13, or it may be less in height toward the center of the beams, as shown in *e*, Fig. 11.

Fig. 14 is a detail of the beam.

Fig. 15 shows a side elevation, and Fig. 16 an end view, of a beam composed of a thin metallic I-beam having upper and lower flanges *c* and *c'*, respectively, with web *d* extending the full length of the beam. This metallic beam, having thin metal, which could not otherwise be used, is entirely imbedded in and stiffened by the concrete or other material composing the exterior portion of the solid composite beam.

The lower metallic flange *c'*, Fig. 16, may be strengthened by adding metallic members *w*. The upper flange *c*, Figs. 15 and 16, will be designed to carry the principal part of the compressive stresses to which the beam will be subjected.

Fig. 17 shows a detail for making up the iron or metallic frame shown in Fig. 1.

The beams above described may be used in almost all places in building and foundation construction where quiescent loads are to be carried and may be used the same as iron and steel beams with similar sections. A single beam may be used, forming a single-beam girder, or two or more beams may be used together connected with separators similarly to double or multiple steel beam girders. These beams are especially adapted to foundation work, where they are protected from moisture by the exterior material composing the beam. The whole beam is to be formed and made solid by exterior pressure and can when completed be transported from the manufactory to any place ready for use.

Having substantially described my invention, what I claim as original, and desire to secure by Letters Patent, is—

1. A floor construction composed of concrete or similar substance, strengthened by metallic members as required, formed in the shape of a succession of eye (I) shaped beams placed with their upper flanges close together, in the manner and for the purpose specified.

2. A floor construction composed of separate concrete or similarly-constructed beams each with a comparatively thin web connected with flanges, the upper and thicker flanges forming the floor and the lower flanges forming the ceiling; substantially as specified.

3. A floor construction formed of concrete or similar beams having comparatively thin webs connected with upper flanges placed

close together and having smaller lower flanges prepared to receive ceiling-blocks to go between same substantially as shown.

4. An eye (I) or deck (T) shaped beam formed of concrete or a similar substance having for the strengthening of the web *b* ribs *s* extending across the web substantially as shown.

5. Composite beams of substantially I form placed side by side to form floors or similar structures the flanges of the beams being separated, and the space between said flanges being filled with blocks which are held in position by said flanges.

6. Composite flanged beams placed side by side to form floors or similar structures, the upper flanges of the beams being of unequal thickness throughout the length of the beam, the thicker part of the flange being where the stresses on said flanges are greatest, and gradually diminishing in thickness to the parts of the flange where the stresses on the flanges are least.

GUY B. WAITE

Witnesses:
JOHN I. WELLER,
ALFRED H. HERZOGG.

(Here follow diagram marked p 706)

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Boyle
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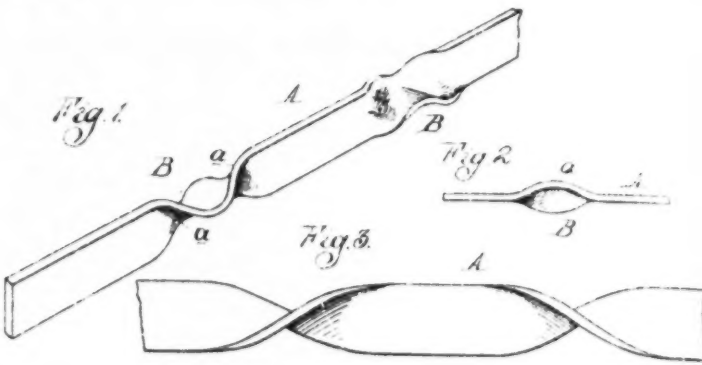
No. 606,988. Patented July 5, 1898.

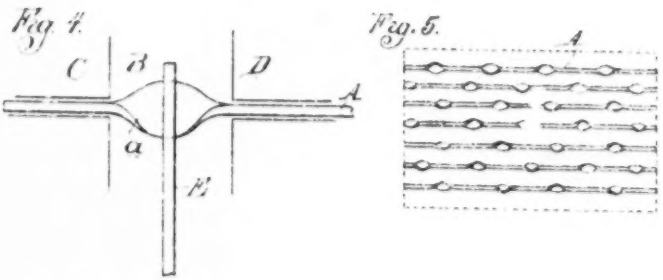
A. DE MAN.

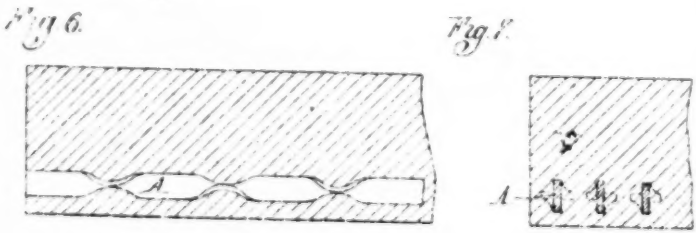
FIREPROOF CONSTRUCTION.

(Application filed Feb. 2, 1898.)

No Model.







Witnesses:
Chas. H. Burke
Thos. B. Boghardt

Fig 8.

Inventor:
A. Gonsons De Man.
By Munn & Co
Attorneys

UNITED STATES PATENT OFFICE.

ALPHONSE DE MAN, OF DETROIT, MICHIGAN.

FIREPROOF CONSTRUCTION.

SPECIFICATION forming part of Letters Patent No. 606,988, dated July 5, 1898.

Application filed February 3, 1898. Serial No. 669,783. (No model.)

To all whom it may concern:

Be it known that I, ALPHONSE DE MAN, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Fireproof Construction, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to the construction of composite slabs or spans especially designed for fireproof-floor construction, and comprising a body of artificial stone having metallic strengthening members embedded therein.

The invention consists, first, in the peculiar construction of metallic members employed for strengthening the slab, and, further, in the peculiar construction of a composite slab or floor span in which these metallic members are employed.

In the drawings, Figure 1 is a perspective view of the metallic strengthening member. Figs. 2 and 3 are views of modifications thereof. Fig. 4 is a plan showing the manner of forming the twists in said strengthening member. Fig. 5 is a plan view of a number of said strengthening members as arranged in position to receive the artificial-stone body. Fig. 6 is a longitudinal section through a portion of a composite slab complete. Fig. 7 is a cross-section thereof. Fig. 8 is a sectional view of a floor construction formed in accordance with my invention.

The metallic strengthening members which I employ are formed of flat and comparatively thin metallic bars A, preferably iron or steel. These bars are provided at intervals with laterally-deflected or partially-twisted sections B, preferably formed, as shown in Fig. 4, by placing the bar in grooved or slotted heads C and D, separated from each other a distance equal to the length of twist to be formed in the strengthening-bar, and then engaging a fork or wrench E, with the center of the section of said bar between said grooved heads, and giving a partial turn thereto. This will form curved shoulders *a*, which when the bar is embedded in the artificial-stone body will form a firm hold or anchor and prevent the slipping of the bar.

I preferably twist the sections B to stand at the center at a angle of about ninety degrees to the main section of the bar, as shown in Fig. 1; but this is not necessary, as I may give a greater or lesser twist, as in the modifications shown in Figs. 2 and 3.

To form the composite slab or span, the strengthening-bars, formed as above described, are arranged in parallel relation to each other in a suitable mold or form with the main portion of the bars standing on edge—that is, with the flat side of adjacent bars parallel, as shown in Fig. 5. The artificial stone in a plastic state is then run in so as to fill the mold and completely surround the bars, thus forming a composite slab, as shown in Figs. 6 and 7, the bars A furnishing the required tensile strength to the slab and being preferably located in the body in a position where the greatest tensile strain will be exerted, such as near the bottom surface of the slab.

The advantage of using thin flat bars twisted at intervals only for forming the tension members is that they may be arranged on edge, as above described, and with a given distance between centers of adjoining bars a greater space is left for the artificial-stone body than with bars of the same strength, but of different cross-section. This facilitates the tamping in of the plastic body between the bars and beneath the twisted portions and insures perfect contact therewith, thus forming a perfect lock between the metallic member and the body and also, on account of the greater mass of the body between the bars, preventing the same from cracking when subjected to strains.

Moreover, the bars themselves are much more rigid to withstand vertical strains when of the shape described than if they were of a round or square cross-section and are also embedded a greater distance in the body, and are thus better protected from the heat in case of fire.

In Fig. 8 I show a floor construction formed by laying bars A across the space between two beams or girders and then filling in the body portion of artificial stone upon a suitable supporting-moldboard, so as to form when complete a monolith floor the spans of which are given sufficient tensile strength by the bars A.

To hold the bars A in place during the proc-

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ces of filling in the plastic material, I preferably provide them with hooks *b* at each end adapted to drop over the flange of the beam.

What I claim as my invention is—

A composite slab or span comprising a body of artificial stone and a plurality of metallic tension members embedded therein, each consisting of a flat thin bar having twists formed therein at intervals, said bars being arranged on edge side by side for the purpose described.

In testimony whereof I affix my signature in presence of two witnesses.

ALPHONSE DE MAN.

Witnesses:
M. B. O'DOGHERTY,
OTTO F. BARTHEL.

x(Here follow diagrams marked p 2/0 &
Pat Office)

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No. 629,477. Patented July 25, 1899.

C. F. STOWELL & A. C. CUNNINGHAM.

WALL.

(No Model.) (Application filed Feb. 19, 1897.) 4 Sheets—Sheet 1.

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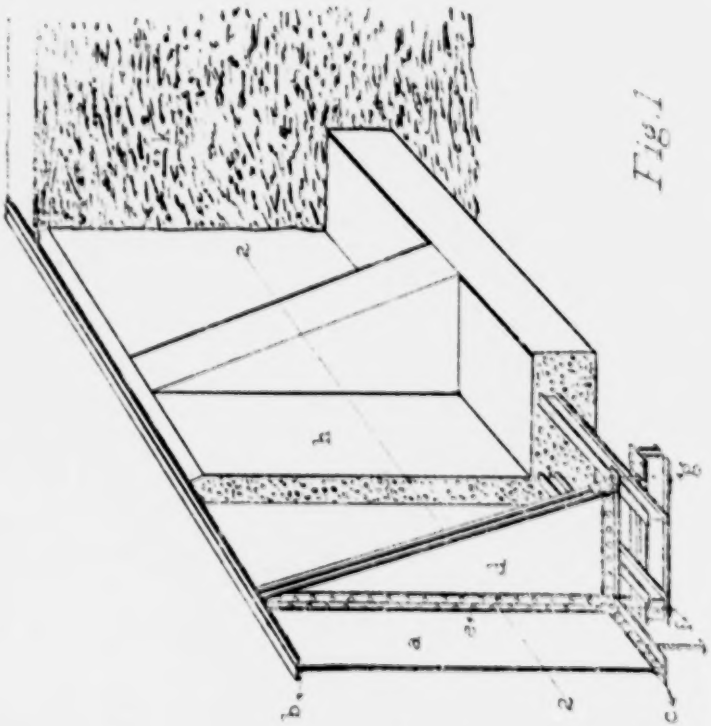

Fig. 1.

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By Cuyler & Carlisle Atty

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No. 629,477. Patented July 25, 1899.

C. F. STOWELL & A. C. CUNNINGHAM.

WALL.

(No Model.) Application filed Mar. 27, 1897. 4 Sheets—Sheet 2.

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moriarty } 212

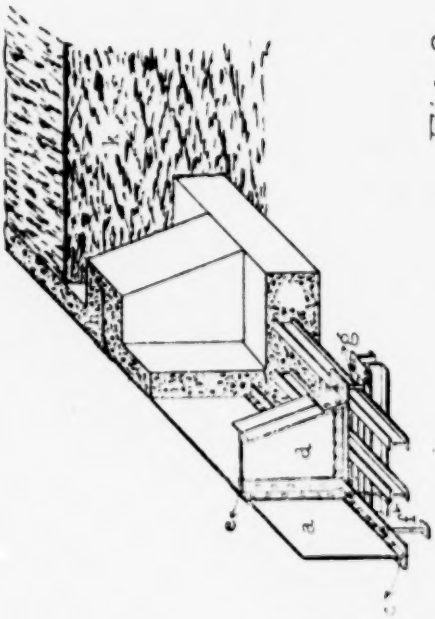

Fig. 2

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By Davis & Carlin
Attys

214

No. 629,477 Patented July 25, 1899.

C. F. STOWELL & A. C. CUNNINGHAM.

WALL.

(No Model.) Application filed Mar. 25, 1897. 4 Sheets—Sheet 3.

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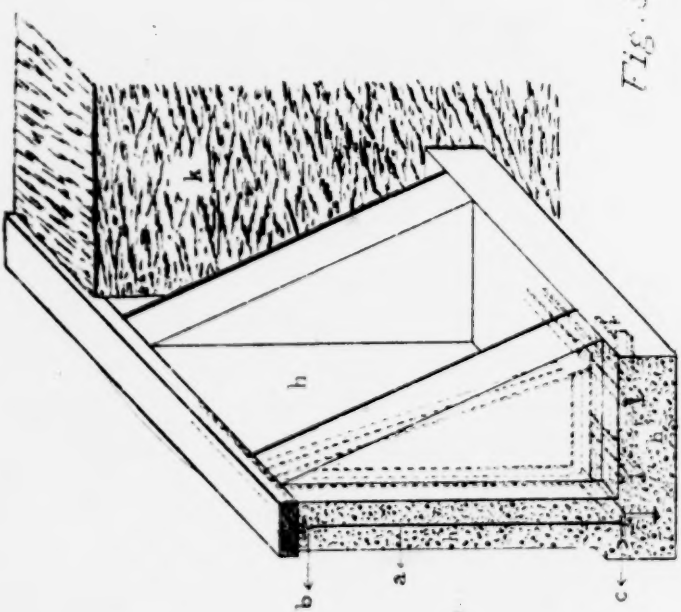
Fig. 3



Witnesses:
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Inventors:
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By
Benj. F. Catlin

216

No. 629,477. Patented July 25, 1899.

C. F. STOWELL & A. C. CUNNINGHAM.

WALL.

(No Model.) (Application filed Mar. 13, 1897.) 4 Sheets—Sheet 4.

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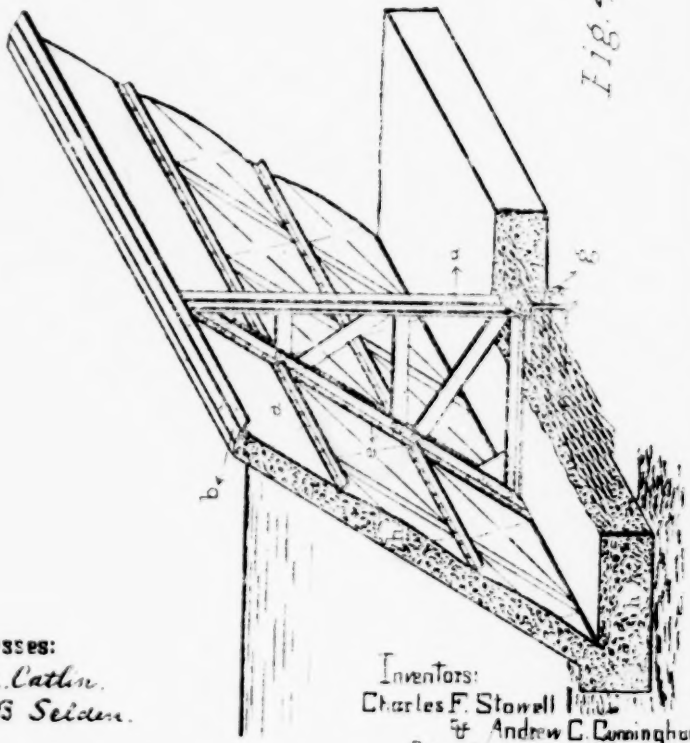
Fig. 4



Witnesses:
C. M. Catlin.
G. B. Selden.

Inventors:
Charles F. Stowell
& Andrew C. Cunningham
By [illegible]

UNITED STATES PATENT OFFICE.

CHARLES F. STOWELL AND ANDREW C. CUNNINGHAM, OF ALBANY, NEW YORK.

WALL.

SPECIFICATION forming part of Letters Patent No. 629,477, dated July 25, 1899.

Application filed March 28, 1897. Serial No. 629,272. (No model.)

To all whom it may concern:

Be it known that we, CHARLES F. STOWELL and ANDREW C. CUNNINGHAM, residents of Albany, in the county of Albany and State of New York, have invented certain new and useful Improvements in Walls; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

The invention relates to walls for sustaining the pressure of earth, water, or other solids or liquids or of superimposed loads, or both, such as retaining-walls, dams, reservoir-walls, piers, abutments, dikes, levees, bulk-heads, tanks, revetments, and the like.

It has for its object to increase the stability and durability of such walls; and the invention consists in the construction hereinafter described and particularly pointed out.

In the accompanying drawings, Figure 1 is an isometric view, partly in section. Fig. 2 is a section on line 2 2 of Fig. 1. Fig. 3 is an isometric view, partly in section, of a modification. Fig. 4 is an isometric view, partly in section, of a modification of a different kind.

The improved wall is constructed of plates of iron, steel, or other suitable metal stiffened at the top, bottom, sides, and such intermediate points as may be necessary by angle-iron or other suitable stiffeners and braced at suitable intervals by knee-braces attached to the wall or face-plates, the whole being covered on one or both sides by a layer of cement, mortar, or concrete and resting on a concrete foundation, to which it is fastened by bolts or other suitable means at proper intervals. The weight of the mass of material superincumbent above the foundation keeps the latter in place and prevents overturning, while the foundation itself is stiffened and strengthened by embedding in it iron or steel in the form of beams, channels, or other suitable forms in order to prevent the foundation from breaking between the knee-braces.

In the drawings, *a* represents the metal face-plate, stiffened with angle-iron or like beams along the edges, as shown at *b* and *c*. A knee-brace *d* is shown, riveted or otherwise secured to the face-plate, as indicated at *e*. The knee-brace and face-plate may be bolted to foundation I-beams and channel-beams of metal, as indicated at *f* and *g* in the drawings. The improvement is, however, not limited to the particular form of these foundation-beams shown in the drawings nor to beam-stiffeners. The face-plate is backed by a suitable concrete or cement covering, and the braces and foundation-beams or other stiffeners are embedded in the same. Concrete is denoted by *h* and earth or other superposed material by *k*. The front face of the plate can also be covered with concrete, as indicated in Fig. 3, or the front face only of the plate can be so covered, leaving the rear face and braces exposed, as indicated in Fig. 4. Fig. 4 further illustrates a different form of knee-brace from that indicated in the other figures, the form and construction of the knee-braces not being essential. Fig. 4 also shows face-plates constructed of buckle-plates instead of flat plates, such construction being advantageous to certain cases, and it illustrates a modification of the method of stiffening and strengthening the foundations by the use of expanded metal instead of I-beams, as shown in the other figures. A portion of the concrete foundation in Fig. 4 is represented as having removed to show the plate of expanded metal embedded in the concrete.

It should be understood that by the term "concrete" we wish to include any equivalent, such as cement. Instead of or in combination with bolts any suitable means may be employed for fastening the parts together. Instead of foundation-bars such as illustrated angles, flat or round bars, plates, pipe, woven wire, wire-cloth, perforated or expanded metal, or other forms may be used, either flat or arched, or two or more of these forms of stiffeners may be combined. It is not essential that the stiffeners or stiffeners and braces be entirely covered with cement in all cases, particularly if some parts be accessible for painting, and it is optional whether or not the accessible parts of either the front or rear of the face-plate or of the braces be covered with concrete or the like. It is important that the face-plate and foundation be firmly connected, so that the latter shall resist a pressure tending to overturn the structure

and resist pressure due to a load and that the foundation be stiffened to resist upheaval between the braces, and that all inaccessible parts be protected by a preservative covering.

The advantages of this form of construction over brick or stone masonry are less cost and greater facility of erection for a wall of equal strength and impermeability to liquids, such a wall being proof against leaks, while should the wall be punctured by design or otherwise the hole is not liable to enlargement by erosion and can be easily repaired. The wall is absolutely safe against the attacks of water-rats or other burrowing animals, which often cause the destruction of earth embankments. It is also free from liability to destruction in consequence of local defects, such as the disintegration of a stone or brick or locally-defective workmanship. It has greater ability to sustain shocks or collisions than a brick or stone wall of equal strength and has less liability to failure in case of undermining of the foundations than a brick or stone wall, the improved wall being self-sustaining over a much greater span.

In constructing our wall as specified we utilize the well-known property of concrete or cement mortar that it is one of the best-known preservatives of iron or steel against rusting, and all portions of the wall which are not exposed to view are covered and protected by such preservative substance, while only portions that are readily accessible for covering with paint or similar preservative coating are left exposed. We also take advantage of the further facts that the adhesion between iron or steel and concrete or mortar is very great and that their ratios of expansion and contraction by heat are substantially alike, so that the bond between them is not broken by changes in temperature.

We are aware that metal beams, lath, and such like structures have been embedded in cement and this matter is not of our invention. Our improvement relates, primarily, to structures exposed to the action of water, floating ice, or other objects and to the attack of animals and in which an opening, however small, when once formed is liable to be speedily enlarged to the destruction of the entire structure or a very material part of it, and it comprises continuous plates, either integral or joined in sections, thereby presenting a continuous defense of practically uniform character to blows or attacks and also providing against the enlargement by flowing water of an opening if one is formed, notwithstanding the continuous protecting-plate. It also comprises foundation-stiffening devices embedded in concrete continuous with the concrete covering of the plates, whereby floating, undermining, and sinking are obviated.

It has been proposed to make walls and floors of a continuous body of suitably-laid brick or stone and provide them with a surface of concrete, brick, or stone, said walls having embedded metal ties, and it has also been proposed to make a jetty of a metal shell filled with concrete and joined to wooden sills weighted with stone. Our improvement is characterized by a metal wall exteriorly protected in all inaccessible parts by concrete or the like, said concrete being continuous in the upright or approximately upright portion and in the foundation, whereby, as above set forth, the foundation-joint is strengthened and the metal is thoroughly protected against rust and whereby the continuation of the concrete in the foundation serves as an anchor and also as a guard against undermining.

Having thus described our invention, what we claim, and desire to secure by Letters Patent of the United States, is—

1. In a wall for sustaining pressure on a face thereof, a metal plate coextensive with the exposed face of the wall, a metal foundation, and a continuous covering of concrete or the like for all inaccessible portions of the plate and foundation, both parts of the concrete being joined at the foundation to prevent undermining or overturning, and to strengthen the joint, substantially as described.

2. In a wall for sustaining pressure, a metal face-plate, a covering of concrete or the like, and foundation-stiffening devices embedded in concrete, the concrete covering the plates and foundation being continuous and said stiffening devices and face-plate fixed together, substantially as described.

3. In a wall for sustaining pressure, a metal face-plate, a covering of concrete or the like, and foundation-stiffening devices embedded in the concrete, said face-plates and foundation-stiffeners being secured together by braces and all inaccessible portions of the metal being covered with a continuous body of concrete, substantially as described.

4. In a wall for sustaining pressure, metal face-plates, a covering of concrete or the like, and foundation-stiffening devices embedded in the concrete, and braces also embedded in concrete and secured to the face-plate and to the stiffeners, substantially as described.

5. In a wall for sustaining pressure, metal face-plates, a covering of concrete or the like, and foundation-stiffening devices embedded in the concrete, said face-plates and foundation-stiffeners being secured together by braces and the braces, stiffeners and the back of the plates covered with a continuous body of concrete, substantially as described.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

CHARLES F. STOWELL.
ANDREW C. CUNNINGHAM.

Witnesses:
JOHN D. WILKINS,
ENRIQUE A. FONCEDA.

A.D. 1874, 18*th* JUNE. N° 2128.

Concreted and Cemented Materials for Building, Engineering, &c.

LETTERS PATENT to Philip Brannon, of 54, Parliament Street, in the County of Middlesex, for the Invention of "**AN IMPROVED COMBINATION AND MODE OF EMPLOYING CONCRETED AND CEMENTED MATERIALS IN UNION WITH OTHER SUBSTANCES IN THE CONSTRUCTION OF BUILDING, ENGINEERING, AND OTHER WORKS.**"

Sealed the 5th December 1874, and dated the 18th June 1874.

COMPLETE SPECIFICATION filed by the said Philip Brannon at the Office of the Commissioners of Patents, with his Petition and Declaration, on the 18th June 1874, pursuant to the 9th Section of the Patent Law Amendment Act, 1852.

TO ALL TO WHOM THESE PRESENTS SHALL COME. I, PHILIP BRANNON, Civil Engineer, of 54, Parliament Street, in the County of Middlesex, send greeting.

WHEREAS I am in possession of an Invention for "**AN IMPROVED COMBINATION AND MODE OF EMPLOYING CONCRETED AND CEMENTED MATERIALS IN**

UNION WITH OTHER SUBSTANCES IN THE CONSTRUCTION OF BUILDING, ENGINEERING AND OTHER WORKS" and have petitioned Her Majesty to grant unto me, my executors, administrators, and assigns, Her Royal Letters Patent for the same, and have made solemn Declaration that I am the true and first Inventor thereof.

NOW KNOW YE, that I, the said Philip Brannon, do hereby declare that the following Complete Specification, under my hand and seal, fully describes and ascertains the nature of the said Invention, and in what manner the same is to be performed, in and by the following statement and the Drawings therein referred to (that is to say):—

My Invention has for its object improvements upon my former Patents, No. 2703 of 1871, and 1246 of 1874, granted to me in relation to my mode of employing, combining, and treading concreted, cemented, and cohering substances with each other and with fibrous materials, and an imbedded continuously permeating webbing of open fabric sustained upon and united with a wholly or partially imbedded skeleton, rim, frame, selvage, or border, whereby I am enabled to remedy the several defects in the provisions of the said former Patents or which are inherent to some of the materials used, and so as to admit of the same being more advantageously employed for engineering, building, and other constructional purposes by either superseding the employment of wood and iron, or being so disposed as to effectually utilise and protect the wooden and metallic material employed in the same structures, and consists of improvements in the formation and employment of felted stone sheetings or pieces composed of the aforesaid materials arranged in the order shewn in Drawings 3 and 4, from a quarter of an inch up to any required thickness with such rigidity, flexibility, tenuity, and strength as are requisite in the works executed thereof, and so as to be perfectly continuous and unbroken throughout the whole extent of any one separate slab, piece, sheet, or structure, and also either to preserve like continuity throughout all the periphery, ramifications, or partitions of cellular compartition and tubular works, or construct them as compound works of framework of my said combination filled in with the said separately formed slabs, sheets, or pieces, in every case having a skeleton frame or selvage combined with and sustaining a permeating open mesh webbing, and ties or tension bonding, strands, embedded, connected, and continuous throughout the entire extent of any one structure, slab, open framework, or piece. For this object the materials and processes men-

tioned under the said two Patents as being used separately I now employ in a combined form in conjunction with my present improvements in the employment of the same for certain purposes, thereby securing much greater strength, durability, and effectiveness, increasing the facility of construction and considerably lessening the cost thereof, and being thus also enabled to form whole sheetings of any superficial extent or parts of sunk or panelled works of extreme thinness, or to combine such thin sheetings or panellings in one with stiles, stanchions, or ribbings of any required thickness and strength.

And in order that my said Invention may be more fully understood and readily carried into effect, I now proceed to describe in detail the several parts thereof under their respective heads, making reference to the Drawings accompanying this Specification by the numbers marked thereon.

Firstly. I compose the said imbed frame shewn in Figs. 1, 2, 4, and 6 as a rigid skeleton wholly or partially of wood or bamboo or as a flexible selvage or as a web frame, or of cane or any ligneous or fibrous material in combination with and sustaining in tension a permeate webbing, also shewn in Figs. 3, 4, 6, 10, 15, and 11, and formed as a strained open warping or other fabric of wirework, or the skeleton or selvage is made wholly or partially of metal, and the permeate webbing of ropes, cordage, or other fibrous material, or of cane or tough wood or the skeleton or selvage, and the permeate webbings and tension seams are formed of any required mixture of metallic ligneous and fibrous materials and termed compound. Where the strains are heavy as in bridges the wirework is formed with wire cables or rope, or 2, 3, or 4 strand twist and the like. Where elasticity is especially desired I also use steel and brass wire twisted, plain, coiled, or spiral.

Secondly. In employing masses of concreted, cementitious and earthy materials in order to give the greatest transverse strength, tensile cohesion, toughness, or flexibility, according to my principle, by the use of filamentous and fibrous substances combined and disposed therewith, and arranging the same in the various forms of lamellated, seamed, felted, fibrous, and ligniform or wood like structure, as set forth in the said second Patent, I now employ either variation of my method of fibrous disposition and laminated or tension structure in union with either composition of skeleton and permeate webbing, or I gauge and

combine the materials by any gypsum, lime, or cement, or with any of the gummy solutions or any of the oily, resinous, or bituminous media under the former Patents specified or herein otherwise explained, and I form therewith structures and pieces of any shape, thickness, or dimensions, either as compressed blocks, slabs, or scantlings or as continuous masses or sheetings formed on platforms or between clamps, or laid by hand upon a bed or platform clamping as otherwise further explained.

Thirdly. In determining the preferential employment of woody, fibrous, or metallic materials in the said skeleton selvages and permeate webbings, and of fibrous, solid, or concreting and cementing substances in the investing masses. For temporary light, cheap, or rough construction, such as huts, low class cottages, and byres I use in the said imbed work chiefly ligneous and fibrous material, and in any structures or parts where the skeleton is deeply imbedded and well protected from fire and decay I form it partly or entirely of wood, but the main permeate webbing sustained by it, or lowest tension seams in exposed ceilings or soffits, are of wire fabric or strengthened by principal strands of wire at short distances if it be formed as a compound web, which I find useful for brattices, flexible sheetings, and marine works, and when the woody or fibrous materials can be previously subjected to preserving processes. The aluminous, saline, and metallic are used for work liable to take fire, and the charring, oily, and resinous for those exposed to damp, and in gauging the materials for ceilings and other soffits, doors, fittings, and fixtures, or any surfaces liable to severe fire, or for work requiring special hardness, rigidity, flexibility, or increased powers of resistance to the action of water or fire. I also employ as requisite comminuted silica, the crushings, wool or fibre of slag or glass, and oxides of zinc, iron, and manganese, in addition to suitable burnt clays and the strongest hydraulic aluminous limes or cements, as well as adapt the media of slacking and cohesion thereto, as partially referred to in said former Patents.

Fourthly. In my present improvements, in the structure of the skeletons, when formed of metal scantlings, angle or tee iron, and the appliances are available for the requisite heating and turning of the same, I prefer to make the connections in a truss jointing by heating the scantlings at the points of intersection or meeting, and giving them a single or double twist about each other, as shewn in the Figure 1, thus

preventing loss of strength by the usual method of punching holes and bolting or rivetting together. In forming compound imbed skeletons, framings, and trussings for the sustaining ribbings and the permeate webbing, wood is employed for the compression members, and thin iron scantlings hoop iron, or wire, or rope, or cord for tension, as in Figure 2. Wooden members in trussings and filletings are cut with skew or inset splay edges, so as to hold the investing concrete dovetailwise, as shewn in Figure 5. In web skeletons and webbings, in some cases for ease in manipulation, I first stiffen them by saturation and drying in a cream of the cementing employed for the piece whilst being held in tension, and in all cases intersecting strands of webbings are best twisted with or bound to each other to prevent separation of the investing mass, as also shewn in Figures 1 and 2, 5 and 6.

Fifthly. In the treatment of ceilings, girders, and all bridging members and constructions, I keep the webbings at the utmost stretch during the laying and setting of the concreting materials about them by any of the known means, such as by stretchers with extension screws or wedges, as Figure 6, or by tender hooks, or by key wedgings to the junctions of the members, as also shewn in said Figure. In the case of large girders, bridges, and the like, I obtain my straining force by purchases acting from anchors or other moorings or immovable holdings, and when there is sufficient time for setting I dispense with transverse trussings over considerable areas by making the imbed stretching frame, rim, or border of large scantling, so as to form therewith an effectual skewback. I then forcibly expand the frame, and bring the webbing into tension far above the calculated strain on the floor or bridging, and as aforesaid keep it so stretched until the full set of the concretings about and above it, which are so disposed in arcuate or cambered layers as to bear upon the skewback rims, see Figure 6. I also dispose the great strength of the tension work in the plane in which tension force acts on the structures, and keep all the main tension and permeate webbings, bonds, or ties fully stretched.

Sixthly. In the employment of the herein described combination or compound structure and other improvements for all the kinds of work herein described, and for all the structures, works, and purposes described in the said former Patents as formed otherwise under their special provisions, and in improvements in the employment for my purposes of the known moulding and concrete building appliances.

In preparing the moulds, bed moulds for ceilings, clampings, and other apparatus to contain, form, and compress the materials on my system, as far as practicable they are formed of wood seasoned and then slightly saturated with oil, the mould faces being treated so as to prevent the adhesion of the materials. Where a wide smooth surface is required, as for plain ceilings, I prefer to overlay with lead sheeting, and I also use any ornamental moulds of zinc or lead, or of mastic, resinous, or asphaltic composition in combination with the apparatus in first setting of the work. To apply compression to concreted walls as they go up I grip the clampings at short distances with powerful grippers, having a gauge rod of the requisite opening and a setting screw or wedge to admit of rapid fixing and removal, and I secure the regularity and true facing of the clamp boards by rebated edges and turnbuckles at the backs for a smooth face of internal plaster, or with butting edges, joint fillettings to the face, and back turnbuckles for jointed faced walling. In sea walls when boards are used, they are weighted to prevent flotation, but I prefer iron framework and galvanized plates on the sea face. And in running two separate substances and mixtures into a mould or clamp at the same time as the hearting and facing stuffs in ornamental fixed work, or the skin and sand filling of sand bags and caissons, I separate the materials during deposition by means of thin boards or metal sheets called draw plates.

Seventhly. In the improved manufacture of pieces and articles on my said system of moulding under direct pressure, the component materials of which are shewn in their order in Figures 3 and 4, in moulding doors and other panelled work having the flanges of tee or angle iron skeletons shewing as a case or rim externally; before setting the skeleton into the mould to keep its place open and secure flushing, I set a dummy skeleton or fillet in its position until the facing pattern is fully run in and the due proportion of fibrous hearting is deposited thereon. When the metal skeleton with its permeating web is placed and covered with the proportion of fibrous hearting and fine facing stuffs to form the panels on the upper side, then dummy panels corresponding with those of the back or upper mould are laid thereon, and the fibrous hearting is levelled with the dummies for the stiles and rails, and covered with the ground or general colors of the fine facing; they are then removed, and the back mould, having been overlaid with the strongly prominent colors and markings to run into and blend with the facing stuff, is laid down and

pressure applied, at first gently, but steadily increased as the setting advances. All kinds of double-faced work, such as panelled partitions and screens, sliding, lifting, or fixed shutters, cupboards, and the like, are thus treated, but where only one side is visible and the other is to be attached and covered up the facing is formed in the bed mould and the back simply levelled, and omitting the upper facing shewn in Figure 3 it is left with a coarse fibre or strong keying face under a plain clamp or platten for the back mould. Imitation wainscottings or other overlays for walls, for decorations, and the like, are formed in the latter mode.

Eighthly. In the formation in like manner of slabs of said materials and structure for roofings, ceilings, groyne spandrels, and other soffils, floors, and the like, for the purpose of securing the necessary transverse strength all these have their moulded soffil ribs, rails, or stiles of depth proportioned to the span or decorative design, Figures 4, 7, and 8, and when the latter is shallow or plain the ribbing for strength will be formed above or in the back of the piece, Figure 9. When the said ribbings are deep in the soffit or face (which is always in the manufacture formed in the bed mould), the prominent graining figures or veins of the color pattern being run on the mould surface in order to give the general facing to the sides of the ribs, and allow the fibre stuff to close upon it. Draw plates are used during the simultaneous running in of the hearting and facing stuffs, being withdrawn before forcing the materials together and into union with the imbed skeletons and webbings. When my own or otherwise known prepared ornaments or tiles are to be inlaid in the principal face the pattern is drawn on the bed mould, the prepared decorations laid thereon, and the materials according to my system run round them; then the fibre stuff, skeleton, and webbing, and the rest of the body formed, and the whole compressed together. If ornaments are to be inlaid on the back or upper surface fillets or panels are to be attached to the back mould to form housings, and the ornaments in that case are set therein afterwards in the usual manner. Rough compression slabs for the formation of camber arches to carry floors and for other purposes are of course formed in rough moulds without facing stuffs, and shewn in Figure 20.

Ninthly. In executing on my said system any open work, such as sashes, casements, pierced or open brackettings, scrolls, panellings, parapets, ballustradings, spiral and wall tailing stairs, and the like, for all such work I form each opening on the bed mould by a separate core

collapsing to or separating from the core, the splays, chamfers, or raking mouldings on the upper side being arranged in connection with the back mould. The permeating trussing ties, braces, and webbing are prepared to set accurately into and pass through all the solid members of the pattern, and the pieces formed, as herein-before seventhly and eighthly explained. Any metal or wood in the skeleton and newel eyes, shafts, or centres in spiral stairs, or tails to fix into the main structure are arranged to be deeply and permanently imbedded and secured.

Tenthly. In the execution of all tubular and columnar work on my system the powerful permeating web is made to pass through the centre of the tubular skin (Figure 10), or at a slight distance within the peripheral surface of any solid column (Figure 11), and whether formed in situ or in a factory is wholly cemented in strong fibre stuff with joint bonding, and has its body formed of thin fissile stone, tiles, or stone felt slabs laid therein truly level or at right angles to the columnar axis, in which direction it is condensed and subjected to pressure in excess of the safety fact of its calculated strain, the surface decoration being executed in manner aforesaid by means of draw plates protecting the facing stuff to blend with the figuring on the clamping mould, which is set up in sections and held by powerful cramps, clips, or grippers acting compressively with and resisting the force of the principal direct pressure. The said clamp moulds are formed to give any ornamental sunk or relief work, rebated or flanged joints, mouldings, heads, caps, or bases in the operation of moulding to any water, sewer, stack, or other pipes, detached and safety flues, as shewn in Figure 12, as well as solid or hollow columns. By the employment of otherwise used divisible cores of proper curved shape I form screw, spiral, single, double, or clustered flues, or give both spiral periphery and pargetting by the known means of the clamp mould and core shifting up or down screw ways, Figures 13 and 14. I also employ my hollow column as a buffer column to deaden vibration in floors or structures above, which rest by a bearing block on sand filling, or in air, water, or other springs, or other cushioning material placed in the cavity, such block being cup shaped in order that pressure may be better conveyed to the solid foot of the hollow column (Fig. 15). Columns for bridges or landing piers are formed on a cutting edged curb ring to sink (Figure 26); they are advantageously filled with sand in some cases instead of concrete, and the pressure taken on the said buffer principle. If a column be fixed in

lengths some may be treated as sand ballasting or coffer cases, and other lengths set inside these with cup bases as butters, or they may lodge, butting in a socket in a moulded flange or internal collar as shewn in Figure 26, the exact mode of connection being dependent on circumstances. Any such columns are made very advantageously in either way to be filled solid after setting by rammed concrete, or flatness, and the like. Hollow girders are formed in the same manner as tubes, as also subaqueous tunnels of any size to lower into the bed of a river where a transverse channelling has been prepared by dredging or other excavation, and where desired any tubular structure formed in pieces of any dimensions has corresponding screw threads cast in the inset end and collar or flange, so that when the same are paid with the cementing medium suitable to fix, or with an unsetting lubricative mixture for detachment as required the pieces are connected with an unyielding air-tight and water-tight joint.

Eleventhly. I form, as aforesaid, any ordinary solid ceiling floor, upon a bed mould, similarly to the mode of working otherwise, herein fifthly sixthly, seventhly, and eighthly described, producing the finished soffit and cornice with any moulded ribs or centres and the like in one continuous operation. When the ceiling is coffered or in bags formed by girding, binding, and sub-ribbings, the whole finished soffit is prepared for by the requisite fitting up of the bed, mould, clamp, or platform, in raised boxings for the coffers, forming between them the channels for the ribs, with all their mouldings in reverse (Fig. 16). Light roofs I construct, as shewn in Figure 18, for a camber crown, with transverse beams of my said materials and structure at suitable distances, carrying a continuous hand-laid sheeting; or the light pitch roof is also made as a continuous sheeting, on longitudinal purlin and ridge ribs of same material, bearing at distances on walls or monolithic trussings, as Figure 17. Eaves, gutters, and other water tables, are either formed solidly in situ, or manufactured as pressed pieces, as well as stack pipes, stack and gutter heads, and the like, Figures 17, 18, and 19.

Twelfthly. I formed, as aforesaid, naked floors and roofs to receive ceiling and flooring or roofing slabs, by the use of moulded boxings or channel clamps, for the construction of the naked girding, binding, or joisting ribs, in floors, or for the principals and trussing in open frame roofs, the embedded skeletons, bracing, trussing, and webbing

being carefully adjusted to the strains, and the flanks and crowns of the members assuming in the said boxings the exact contour to house and fit the roofing, ceiling, or flooring slabs (Figures 19 and 20). By a like open framework composed of standards and rails of my material, fitted by grooves, rebates, or other housings or attachments, to receive slabs, and which are separately formed by moulded pressure, as aforesaid, I construct whole buildings, especially such buildings as summer houses and the like. For coolness, as for ice houses and cairies, or tropical huts, I use a double casing of such slabs or sheeting and allow air to circulate through the cairties, as a circulating air jacket, or for warmth or sound stopping I fill the cavity with non-conducting materials as commonly known.

Thirteenthly. I form floors or roofs of any form and of great strength and lightness, in a compartition or tubular structure, in my continuous sheeting, with the permeating webbing and trussing ramifying and reuniting continuously and unbroken, throughout the same in the ceilings, divisions, and floor, and I utilise the cavities either for a circulating air chamber for drying, warming, cooling, or other purposes, as in Figures 21 and 22; or for alternate eduction from the ceiling below, and induction to the floor above, in ventilation, Figs. 23 and 24.

Fourteenthly. In the formation with my said continuous sheeting, or with walls, floor, ceiling, and doors of my material, of any fireproof closets, rooms, or compartments, or entire fireproof casings to structures otherwise combustible. Separate fireproof rooms in such structures, if not directly bearing on supports connected with the ground, are carried by connection with and bearing on the solid walls of brick or stone and the chimney stacks. In combination with my present improvements, and otherwise as explained under said former Patents, I protect all wood and iron and shut off damp and miasma by a perfect hand-laid sheeting, insulated as formerly described and herewith shewn in Fig. 25. The insulating of such sheeting secures between it and the material to be defended or insulated a space to be employed as an air jacket, or to be packed with material for sound stopping or non-conduction. All doors on my construction inserted in partition or other solid walls convert such walls into complete fireproof divisions or fire casings, as I use under my present improvements no wood or iron frame, but attach doors by hinges or trailing plates to the wall itself, or to sill and head plates by centres, so as to fit closely in their reveals.

Fifteenthly. In all my bridging structures the sheeting forming vertical sides, bulwarks, partitions, and the like, constitutes the supporting or suspension girdings. When desirable they can be made perforated as for a landing pier (Fig. 26), or as an open-framed roof truss, as already shewn in Figs. 17 and 19, and in all such openwork, however formed, the skeleton, its bracing and trussing or tension members, webbing, and suspension rods, are continuously connected in and through the solid portions of the work.

Sixteenthly. I form aqueducts, sewers, roads, railways, and canals over morasses or lake waters of my continuous trough-formed sheeting, to dispense with piers and rest on or in the mud or water, as shewn in Fig. 27, and for roads, so as to rise and fall with the same and the load. In the first instance they can be laid on raftings of planks or timber and part or the whole thereof afterwards removed.

Seventeenthly. I also form of my said continuous sheeting roads, railways, and canals, as continuous trough-shaped girders, in long spans between supporting piers and columns of any height. Fig. 28 shews a trough-girder canal with its side waterways and transverse girdings, bindings, and trussing work. I also when preferable form the main part of such viaduct or aquaduct work with commonly known arches or arched ribs, and tie the whole together by a continuous sheet, floor, road, or deck of my said construction.

Eighteenthly. I form also as caissoons of the said sheeting floating docks, tanks, cisterns, or reservoirs, or safety foundations for buildings upon swampy ground, or sites liable to floodings, the entrances being either over a parapet or through it by water-tight gates, or the entire structure is set on feet between guide piles, so as to rise buoyantly in case of freshets or tides without danger.

Nineteenthly. I construct all kinds of sea works by means of the same sheetings. Sand bags under these improvements are made and used either in the ordinary form or forced in a mould to a fixed shape, as Fig. 29, or lowered into place while soft and then rammed into the permanent position, so as to fit immoveably with the surrounding sacks, as shewn in Fig. 30.

Twentiethly. All large bags or encasements of my said continuous sheeting I treat as caissoons, so as to have a proper contour for the neutralisation of the wave stroke, the arresting of warp, or the deflec-

tion of the currents. I form therewith exact sectional portions of larger works, as piers and breakwaters, to be built in situ or upon trollies, platforms, or pontoons capable of being lifted or floated, lowered, and adjusted in position, and so as to be filled either with concrete, sand, or water ballasting. When built on a foreshore in situ, and the sectional joints are not wanted to be water-tight, I form them with a horizontal diaphragm, as Fig. 31, making the skin and filling the ballast at the same time by the employment of draw plates. In all other cases I form caissoons with bulkheads, septs, or partitions, transversely to the line of the work and their sectional ends or faces by the overlaying of battens in the clamping; I provide with corresponding joggle, grooves to be afterwards water-tight caulked and joggled. When not built in situ, but lifted and floated into position, I also form hatches in the crown for filling, and fit the flanks with taps, sluices, or stop-cocks to admit or exclude water in the operations of sinking and adjustment. When used for water, ballusted breakwaters, or cofferdams, on the water inside rising to high-water level the stop-cocks are closed and water pumped into a higher level to give the gravity required. On sand or soft mud I form all such caissoons with a cup base or with a flat bottom laid on a previously set base having a concave soffit, whilst rocky or other bottoms are suitably prepared to receive the caissoons, as at Figs. 31, 33, 34. I also employ my said caissoons as coffer casings to supersede the use of coffer dams, and so as to become parts of permanent structures. I either construct them at low water in situ, or form them ashore and float them into position, by forming in connection with the internal clamp framing a temporary floor of timber so constructed as to be releasable and left to float up when the coffer case is finally set in its place (Fig. 37). It is then externally banked or secured with puddle or sand bags, and the interior excavated and filled up with the concrete or other solid work grouted into one with the coffer itself. The timber trussing of the internal clamp frame is of course removed, as the interior is filled with the solid masonry or concreting, and the lower edge I generally form on a cutting kerb for sinking and other purposes.

Twenty-thirdly. I form also like continuous sheet facings instead of walls to foreshores, the bulkheads acting as counterforts, and the sheet bases utilising the otherwise destructive forces of back water and slipping sand by employing their weight and thrust as a means of stability (Fig. 35).

Twenty-secondly. Sea walls I form as continuously laminated, bonded, and internally trussed beams of said structure in the lower part, kept in tension by the arcuations of the other materials above, and all resting on feet, bases, or piers, which also carry counterforts, so that the greatest portion of the foundation and back walling otherwise necessary are thereby altogether dispensed with, and any degree of strength and durability obtained, as the soffit webbing, tension seams, imbedded trussing, and arcuation of the bedding are continuous through the whole length (Fig. 36). I also give to any wall or partition transverse strength in like manner by the embedded trussing or arching bearing on the heels of tension seams composed of wire, cordage, and fibre, as herein set forth.

I now proceed to further explain the said improvements by the aid of the accompanying Drawings, reference being made by the Figures already referred to in the foregoing description, and marked on said Drawings, that is to say:—

Fig. 1 represents an improved mode of connecting iron trusses by twisting at the intersections; also twisting of all strands at intersection of wire or cordage.

Fig. 2, example of wood trussings with wire or cordage tension members.

Fig. 3 represents an isometrical view of a portion of my sheeting manufactured in accordance with my improvements, shewing the permeating web *c* imbedded in the fibrous hearting concreted materials *b*, *d*, and on finished fine set work covered with one or two proper facings *a* and *e*.

Fig. 4, enlarged section of junction angles of two ribbed roofing slabs, shewing the permeating webbing *c*, the pannelled or sheeting part, and the stiffening frame skeleton or web *f* in the ribbing, to give stiffness and transverse strength to the same.

Fig. 5, inset cutting of fillets in wood to hold concrete dovetail wise,

Fig. 6, sketch of stretchers to a floor without trussings, as explained in 5th clause.

Fig. 7, soffit of a ceiling, roofing, or light flooring slab; Fig. 8, back of same.

Fig. 9, section of ceiling slab with strengthening ribbing above.

Fig. 10, tubular structure or column with the fibrous inearting, encircling permeate web and facing.

Fig. 11, solid column with same, and horizontal bedding of the solid heart.

Fig. 12, ornamental safety detach flue and bend to stove; Fig. 13, spiral or double bend to same.

Fig. 14, clustered spiral flue stack.

Fig. 15, buffer column with the bearing block and sand cushioning.

Fig. 16, solid ceiling floor in cofferings with girding and binding ribs.

Figs. 17, continuous hand laid sheeting pitch roof on open principal purlins and ridgings formed previously or in one with sheeting.

Fig. 18, hand laid sheeting roof in camber form on solid girdings formed successively or together.

Fig. 19, open framed roof covered in with separate slabs formed under pressure.

Fig. 20, naked frame floor filled in with ceiling slabs below, and with camber compression slabs above, supporting the floor.

Fig. 21, section of circulating cavity floor.

Fig. 22, plan of circulating cavity floor, the arrows denoting the direction of the air current.

Fig. 23, section of cavity floor utilised for ventilation.

Fig. 24, plan of cavity floor with the alternate flues or openings utilised for ventilation, and connected with flues in the walls for pure air entering at the floor by one set, and foul air educted by another. The gratings shew the eduction of foul air from the room below. The arrow heads signify the induction and eduction currents, and the blank openings the air flues.

Fig. 25, insolution of fire and damp casing sheet, with the insulating blocks, washers, and attachments.

Fig. 26, pier of continuous monolithic structure, one-half being shewn in elevation, and the other in section, the section of the column representing alternative forms of kerb foot and an inset buffer joint or moulded flange or inset collar and socket joint.

Fig. 27, trough sheeting form of canal, railway, or road on swamp.

Fig. 28, trough sheeting canal carried on piers, half in section.

Fig. 29, sand bags forced into moulds for voussoirs.

Fig. 30, breakwater of sand bags rammed together.

Fig. 31, diaphragm caissoon, section and elevation.

Fig. 32, bulkhead caissoon, crown plan, with the horizontal section in dotted lines.

Fig. 33, same bulkhead caissoon, transverse section, with the joggled joint face dotted.

Fig. 34, same bulkhead caissoon, longitudinal section.

Fig. 35, section and elevation of foreshore casing of continuous sheeting, sustained by base and counterfort bulkheads of same.

Fig. 36, beam wall continuously bonded by imbedded skeleton tension webbings and seams and compression archings.

Fig. 37, coffer case for bridge piers. The internal lines, representing the clamping or shoring, to remain till the masonry or other internal work is completed.

In all the said Figures the close sectional lines indicate the section of the concreted and fibrous body or sheeting, having throughout the same disposition of component materials shewn in Figs. 3 and 4, dotted lines. A second plan of structure or elevation beneath or beyond the surfaces, shewn dotted tints, indicate sand fillings for ballasting or buffer work, and the arrows the direction of air currents, whilst the same letters of reference in each of the Figures denote similar corresponding parts in the Drawings.

The small letters in the Drawing N°. 1, 2, 3, 4, 6, 10, 11, 15, and 25, signify as follows:—*a*, *a*, the finished facing, being fine stuff run in to blend with the hearting bed; and *b*, *d*, the fibrous hearting stuff

embedding the permeate web or framing; *c*, *c*, the permeate web acting in tension, and as continued bonding or tension seam; and *f*, *f*, a frame or skeleton sustaining the tension members, receiving compression and compound strains, and giving transverse strength; and *g*, *g*, simple framing or wall plating acting as a stretching frame only to the permeate web; *h*, *h*, tenter hooks; *i*, *i*, wood stretcher; *j*, *j*, screw stretcher; *k*, *k*, wedges.

A, A, represents section of continuous sheeting or beam structure, with all the parts of the mass disposed as shewn in Drawings, with the small letters *a*, *a*, to *g*, *g*, as above explained, B, B, the section of separate slabs or pieces formed by moulding and pressure, and having their materials disposed as also shewn in the Figures with small letters; C, C, twist intersections of metal; D, D, twisting of cross wires; E, E, dovetail cutting of wooden members; F, F, face floor or front surface of sheeting work; G, G, girding bressomer or joist in one with sheeting; H, H, open frame trussing of roofs or naked flooring; I, I, insulation of blocks and washers; J, J, gutters and stack pipes; K, K, kerb or cutting edge to base rim of coffer case or column; L, L, internal collar and socket column joint; M, M, moulded flange and socket butt joint to column or pipe; N, N, buffer bearing on sand or spring; O, O, open or air space; P, P, partition, bulkhead, sept or withe, in compartition or cavity work; Q, Q, diaphragm or horizontal partition for in situ built ballasted work; R, R, hatches or flaps to caissoons; S, S, sectional joints or faces; T, T, taps, sluices, or stop-cocks to caissoons; U, U, union jogglings on the sectional faces of caissoons; V, V, cupping soffit or bases; W, W, wave breaking contour of sea walls; X, sand buffering to columns, or ballast filling to caissoons and sand bags; Y, clamping or centering where retained for a while to assist in transporting and setting coffer and caissoon works; Z, ground or beach.

Having now fully described and ascertained the nature of this my said Invention, and the manner in which the same is to be performed and carried into effect, I would have it clearly understood that I do not intend by any means to confine myself to the precise details hereinbefore set forth and described, as the same may be otherwise varied without departing from the general principle of these my said improvements, nor do I claim as new and of my said Invention the exclusive use of the several parts, combinations, and processes above referred to except

when the same are employed in and for the purposes of my said Invention, which I hereby declare to consist,—

Firstly. In combining a skeleton frame or selvage of wood or cane with permeating webs and tension seams of wire, or a skeleton of metal with seams of cordage and fibrous material, or forming a skeleton frame selvage, permeating webs, and tension seams of woody, metallic, and fibrous materials imbedded on and uniting with concreted and cemented substances, mixed in any desirable proportion, as herein-before firstly, secondly, and thirdly explained.

Secondly. In forming the skeleton and treating the permeating webbings as herein-before fourthly and fifthly explained.

Thirdly. In employing the above combinations for the construction of works for the various purposes described in said former Patents, and my improved processes for the construction thereof, and of the works herein described as herein-before sixthly explained.

Fourthly. In the use of the said combinations of materials and processes for the formation of all kinds of doors, panelling, slabs, and pieces, either plain or with sunk, raised, or open work for constructional purposes, as already seventhly, eighthly, and ninthly explained

Fifthly. In my mode of forming any tubular work straight, curved or convolate, with any contour and finish of exterior surface and treatment of jointing, as herein-before tenthly set forth.

Sixthly. In the formation of solid columns of the said materials and structure, and the use of hollow columns either without filling in the space, or filled with sand or other material, as for buffer columns, and employed in any kind of construction in single or jointed lengths, as also tenthly set forth.

Seventhly. In the formation of floors and roofs of the said materials, either in one continuous body, as eleventhly explained, or of a naked floor or roof with filled in pressed slabs, as twelfthly explained, or of the herein-before described continuous sheeting and compartition hollow or tubular structure, as thirteenthly explained.

Eighthly. In employing the said sheeting or slabs for any fireproof or damp-proof insulated sheeting, or for strong rooms and compartments, or

separate buildings, and with non-conduction or air jacketing, as eleventhly and fourteenthly explained.

Ninthly. In forming of the said continuous sheeting of roads, railways, canals, docks, reservoirs, safety foundations, and the like, as fifteenthly, sixteenthly, seventeenthly, and eighteenthly explained, and in using a wall, partition, sheet, or deck of my construction for tying together and supporting arches, walls, or other work on known principles, as also seventeenthly explained.

Tenthly. In forming of the said continuous sheeting sand bags, diaphragm, bulkhead, joggled, and other caissoons or coffer cases, and rendering them capable of employment for concrete blocks, sand filling, or water ballasting, or of being used in place of coffer dams, as nineteenthly and twentiethly explained.

Eleventhly. In employing said sheeting for foreshore facing or protection, instead of walling, as explained in clause twenty-one.

Twelfthly and lastly. In employing the said trussed soffit webbed tension and compression beam structure for sea walls, as set forth in clause twenty-two.

In witness whereof, I, the said Philip Brannon, have hereunto set my hand and seal, this Fourth day of June, in the year of our Lord One thousand eight hundred and seventy-four.

PHILIP BRANNON. (L.S.)

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.
[Wt. 35—125/11/1910.]

(Here follow diagrams marked p. 237)

A.D. 1874 June 18. N° 2128.
BRANNON'S Complete Spring Bed.
[Edition]

Fig 1.

Fig 2.

Fig 3.

Fig 4.

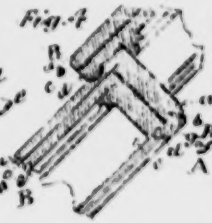


Fig 5.

Fig 6.

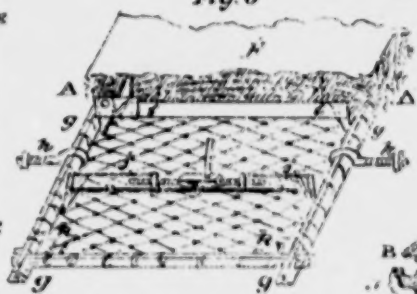


Fig 19.

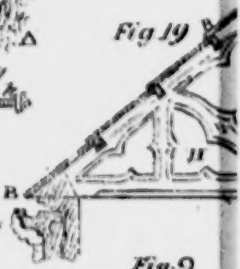


Fig 8.

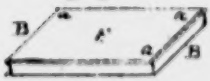


Fig 7.

Fig 9.

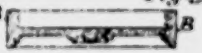


Fig 10.

Fig 11.

Fig 12.

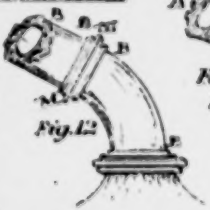


Fig 13.

Fig 14.

Fig 15.

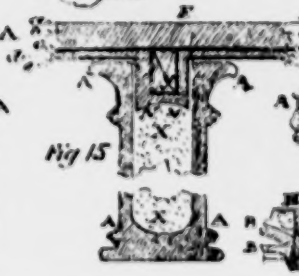
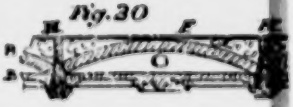


Fig 16.

Fig 30.



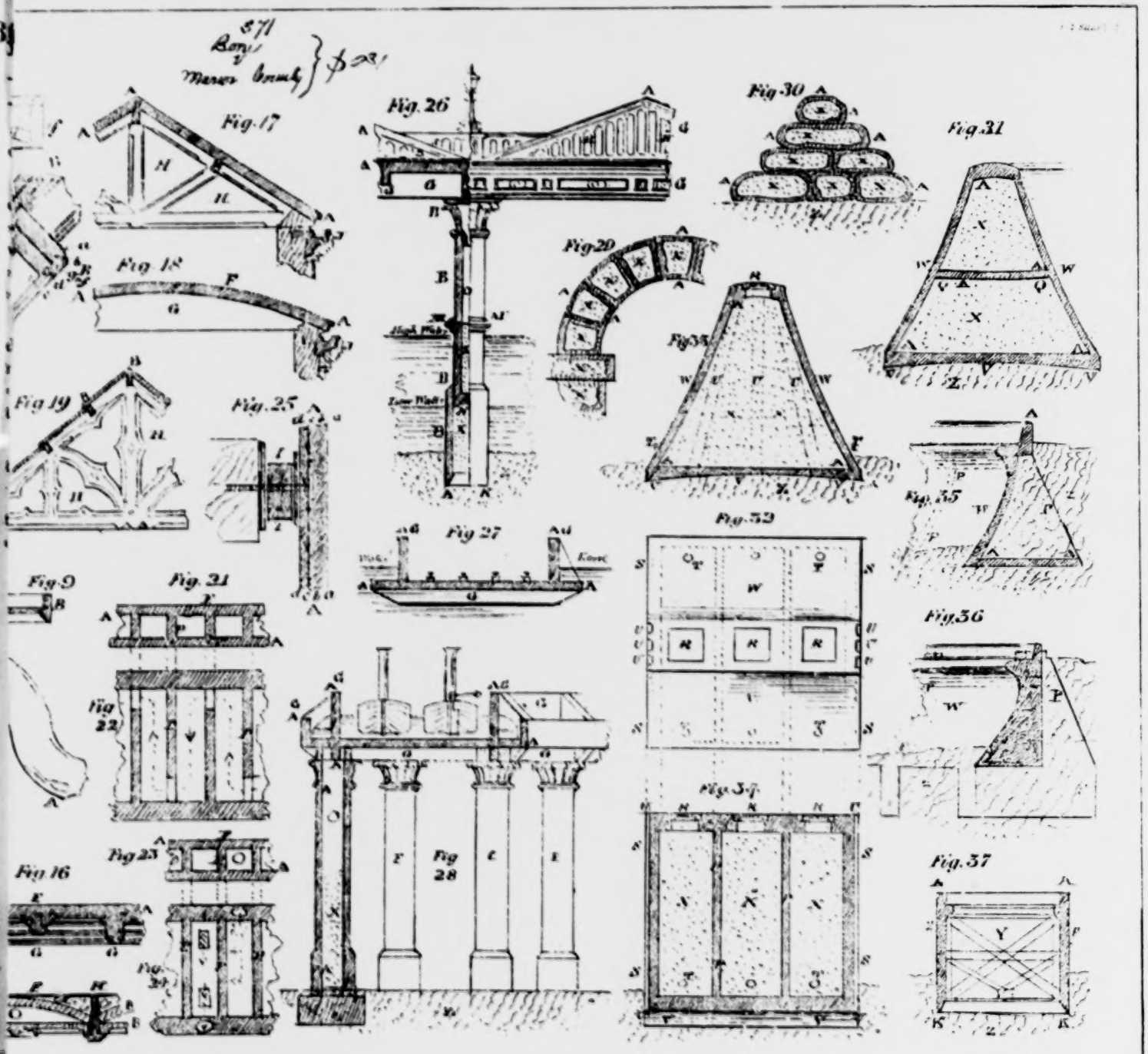


Fig. 17
Fig. 18
Fig. 19
Fig. 25
Fig. 26
Fig. 27
Fig. 30
Fig. 31
Fig. 20
Fig. 33
Fig. 35
Fig. 9
Fig. 21
Fig. 22
Fig. 23
Fig. 16
Fig. 24
Fig 28
Fig. 34
Fig. 36
Fig. 37

A.D. 1884, 7th August. N° 11,021.

Improvements in Retaining Walls.

COMPLETE SPECIFICATION.

I, ALBERT HÜBNER, of Cologne, in the Country of the Rhine, German Empire do hereby declare the nature of my Invention for "IMPROVEMENTS IN RETAINING WALLS" and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This Invention has reference to the construction of a retaining wall made solely of materials forming the front and lower surfaces (a shell or framing so to speak) of a solid retaining wall, which shell is built up with appropriate materials (masonry, cast iron plates, wrought iron buckled plates etc.) whilst the weight or mass properly speaking requisite for the stability of the wall consists in a backing of earth, which arrangement is rendered possible by building in the said shell, at intervals back stays in wrought iron or other appropriate material which are supported on one side by the front facing and receive all the horizontal thrust and on the other side are supported by the construction of the basis and receive the weight of all the earth forming the backing, as well as the reaction of the basis of the foundations.

For the construction of those retaining walls of which in the accompanying Drawing Fig. 1 is a front elevation; Fig. 2 a horizontal section through V W Fig. 1; and Fig. 3 a vertical section through X Y Fig. 2. I arrange at equal distances wrought iron back stays A. Between the vertical front uprights B of the iron back stays, I arrange vertical concave walls C; between the lower horizontal beams D of the back stays A I build arches in masonry E E^1; at the front the arched part is below, because at such part the reaction which acts from below the setting of the foundations is more powerful than the weight of the earth which takes effect from above, whilst at the back the arch is turned upwards, because at such part the pressure is reversed. If this system of masonry is backed with earth (or a similar compacity of masonry and earth) the former will have a stability equal to that of a retaining wall having the same thickness as the back stays A.

A.D. 1884.—N° 11,021. Complete Specification.

Hübner's Improvements in Retaining Walls.

Having now particularly described and ascertained the nature of my said Invention, and in what manner the same is to be performed, I declare that what I claim is:

The construction of retaining walls formed of a shell or framing, their front and lower surfaces being connected at intervals by metallic or other back stays and filled in behind with a backing of earth.

Dated this 7th day of August 1884.

DAY, DAVIES & HUNT,
321, High Holborn, London, W.C.,
Agents for the Applicant.

LONDON: Printed by EYRE AND SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
1884.

Here follows diagram marked p 24/1

A.D. 1884 Aug 7. N° 11,021.
HÜBNER'S Complete Specification.

(1 SHEET)

241

371 Bmc 7 Marion Sq

FIG. 1.

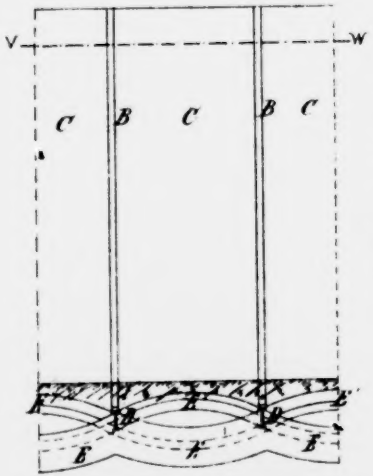


FIG. 2.

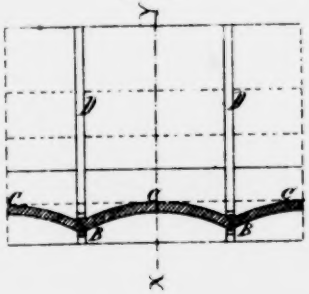
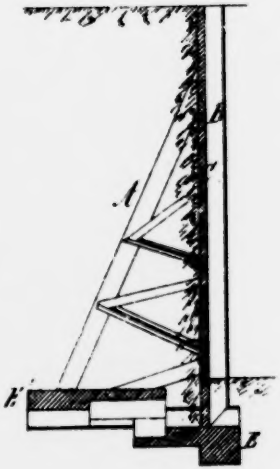


FIG. 3.



234 *Certificate of Clerk.*

In the District Court of the United States for the District of Indiana.

I, Noble C. Butler, Clerk of the District Court of the United States for the District of Indiana, do hereby certify that the above and foregoing is a full, true and complete copy of the record and proceedings in said Court as required by the Praecipe, in the cause of Frank A. Bone, v. Commissioners of Marion County, No. 7293, In Equity, as the same appears of record in my office.

Witness my hand and the seal of said Court, at Indianapolis, in said District, this 3rd day of January, 1917.

[SEAL.] NOBLE C. BUTLER, *Clerk.*

235 *Stipulation.*

Filed Feb. 8, 1917.

In the United States Circuit Court of Appeals for the Seventh Circuit.

No. 2459.

FRANK A. BONE, Appellant,

vs.

COMMISSIONERS OF MARION COUNTY, Appellee.

Stipulation.

It is hereby stipulated that in accordance with the praecipe agreed upon on page 174 and the stipulation by counsel, on page 176 of the printed transcript of record, specifying just what should be included in the transcript of record and just what should be printed, the attached exhibits or portions of exhibits inadvertently omitted from the transcript of record, shall be filed in the above-entitled cause in the Circuit Court of Appeals, as and considered a part of the transcript of record, and shall be printed as a part of the printed transcript of record, and shall have the same force and effect as if they had been included in the transcript as originally filed, said exhibits being the following items specified in the praecipe filed in said cause, as shown on page 174 of the printed transcript of record:

5. Deposition of Dr. Vos and copies of publications therein.

17. Cuts and translations of the Planat Publications, 1894 and 1896, the foreign language to be omitted.

18. Uncertified copy of cuts and translation of Bauzeitung article, the foreign language to be omitted.

246 However, the photographic copies in the deposition of Dr. Vos and the cuts in the Planat publications and the Bauzeitung article need not be reproduced as they are found on pages 115 to 128, inclusive, of the printed transcript of record.

ARTHUR H. EWALD,
Counsel for Appellant.
V. H. LOCKWOOD,
Counsel for Appellee.

Indianapolis, Indiana, February 6, 1917.

(DEFENDANT'S EXHIBIT DEPOSITION OF PROF. VOS, RECORD, P. 56.)

In the United States District Court for the District of Indiana.

No. 7293.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Deposition for Defendant.

Deposition of Bert John Vos, of Bloomington, Indiana, taken in behalf of the defendant in the above-entitled cause, at the office of Theodore J. Louden, at Bloomington, Indiana, at two o'clock in the afternoon of Saturday, January 22, 1916, before Theodore J. Louden in pursuance of the attached authority and notice.

No attorneys appeared for either party.

Deposition of Bert John Vos.

BERT JOHN VOS, being first duly sworn, in answer to the following interrogatories propounded to him, gave the answers as hereinafter set forth:

Q. 1. Please state your name, age, residence and occupation.

A. My name is Bert John Vos. My age is forty-eight years. My residence is Bloomington, Indiana. My occupation is Professor of German in Indiana University.

247 Q. 2. Are you the head professor of German of Indiana University?

A. I am.

Q. 3. What training have you had to enable you to understand and translate Dutch or the language of Holland?

A. I was born in Holland and had my early education until the age of fourteen years there, and I have since taught advanced classes in Dutch in Johns Hopkins University of Baltimore.

Q. 4. Your attention is called to the attached photographic copy

of the title page and an article by Nolthenius entitled, "Mededeeling Betreffende Belastingsproeven met Monier-Platen" from a book "Tijdschrift van het Koninklijk Instituut van Ingenieurs. Verhandelingen, Vertalingen, Verscheidenheden, Boekaankondigingen, Nieuw Verschenen Werken. Instituuts jaar, 1895-1896. Te's Gravenhage, Bij Gebrs. J. & H. Van Langenhuysen, 1896," and particularly page 17 and to the end of the first paragraph on page 18 of said article. Does any of said article describe or refer to Fig. 6 on Plaat- 2 excepting the last paragraph on page 17 and ending on page 18?

A. It does not.

Q. 5. Please attach a correct translation into English of the title page and page 17 and to the end of the first paragraph on page 18 of said article, including the title at the top of page 17, and write with ink on the drawings the translation of the words thereon.

A.—

Translation of Article by Nolthenius.

Journal
of the
Royal Institute
of
Engineers.

Transactions, Translations,
Miscellanies, Book-Announcements,
Recently Published Works.

For the year
1895-1896.

The Hague.
(J. & H.) van Langenhuysen Bros.

248 Tests with Loads on Monier Plates.

These curved plates lay on free. They were not, therefore, subjected to lateral pressure and accordingly did not really function as arches.

The four plates broke, on an average, under a load of 978 kilograms applied in two places, each situated 0.25 meter from the middle of the plate. The concrete was again made in the proportion 1:3, but this time — these tests were among the first made — unscreened sand was used, and the fact that pebbles occur in unscreened sand may perhaps to some extent have affected the strength.

In the case of one plate (No. 32) the mixture for the parts situated near the points of support was composed of screened coal slack instead of sand, sand being used for the middle portion only, one meter in length. This was done for the purpose of making the plate lighter, and since the break always occurs in the central portion,

this could not result in a decrease of strength. The decrease in weight — the plate just described weighed 139.5 kilograms, the others, on an average, 152.5 kilograms — is, however, not considerable enough to justify the greater trouble involved.

The curved plates were not embedded on either side, for the reason that, in actual practice, the embedding will, as a rule, be found to be imperfect. For, in order that plates of this kind may obtain the required firmness, the concrete must be tightly rammed. If one were therefore to make these curved plates in the position they are to assume i. e. between the beams, one would have to construct a very strong scaffolding, on which the forms could rest, during the ramming, without danger of bending or giving. This is costly and it is, therefore, preferable to prepare the curved plates beforehand on the level ground. In that case the form need not be of heavy construction, for it can be made to rest on sand. In that case also only few forms are needed, for the plates can then be made in quantity, and whenever the curved plates in process of manufacture are sufficiently set, new plates can be made in the same form.

Such plates may then, after the beams have been placed in position, simply be shoved in between these beams from the side,
249 before the erection of the walls is further proceeded with. This affords the further advantage that there is at once a floor in the building.

The curved plates weighed approximately 67 per cent more than flat plates having throughout the same thickness that the curved plates have at the top (5 centimeters), whereas the increase in strength is only about 35 per cent.

But, as will be readily understood, the ratio becomes more favorable when the arches are embedded. A plate (No. 33) in which the main rods were joined was embedded between two beams that were united with iron bars and did not break until the load amounted to rather more than 1,160 kilograms, so that its strength was approximately 20 per cent greater than that of the beams not embedded. With loads applied from the side an even greater difference was observed (Nos. 34 and 35).

This embedding can, of course, in the case of beams be effected by pouring the spaces between plate and beam full of cement mortar.

As a rule, one can without difficulty give such curved plates a greater degree of curvature than was done in the present instance, where it amounted to only 1:30. This would, of course, carry with it a considerable increase in strength.

Aside from these curved plates, three other curved plates were recently tested that were somewhat shorter and likewise a little higher and wider. They had been left over from the construction of some dwellings for officials. These plates, about a year old (Nos. 64, 65, and 66) bore a load somewhat less than might have been expected in view of the results obtained in connection with the above-mentioned curved plates. In the examination after the fracture it appeared, however, that the main rods in the top lay relatively far from the lower side of the concrete, so that the arches in the top were actually weaker than would otherwise have been the

case. This less advantageous position of the rods was presumably the result of a manufacture in quantity. Now that attention has once been called to it, it will, however, not be difficult to guard against a repetition of such an occurrence.

250 Curved plates can, in my opinion, with advantage take the place of arched brick masonry, which is sometimes employed in protection piles. It is even possible to give these Monier arches a far greater degree of curvature than is found in the case of arched brick masonry, where it amounts to from 1/12 to 1/15 of the span; partly since in the top they can be made half as thick, partly since they need not rest with their top on the "watersloof," but may without objection project from behind the latter, since they are already hardened before they are put in position.

In order that in some particular instances not only the arched brick masonry, but also the protection piles on which they rest and even the anchors that guard these against overturning, might be replaced with a single Monier construction, the test piece was constructed that is shown on Plate 2, Fig. 6. The flooring was given a sufficient width that the moment of pressure of the earth against the floor was greater than the moment of the horizontal component of the pressure on the upright, both of these considered in relation to its base so that no anchoring should be necessary. As the rule, therefore, this is the case when the ground plate is given a depth equal to half of the height of the upright; and as a matter of fact a similar test piece remained standing when it was tested under the pressure of a pile of pure sand. A similar piece could be placed directly on a dirt bottom, or, better still, on a bed of gravel. It could for example, be used for the sides of a canal or for low walls where it is desired not to lower the height of the water during construction. For these units can be placed in water. If the floor is given a width equal to the height of the upright, there will, as a rule, result a fourfold security against overturning. It will, however, also suffice to place in the upright an anchor, which may be situated far above water-level and which is therefore easily adjusted.

Q. 6. Have you examined the attached photographic copy of the title page of a book entitled "Ausgewählte Monier-und Beton Bauwerke Strassen und Eisenbahn-brücken Hochbauten, Silos, Futtermauern, Känale U. S. W. nach den Ausführungen der

251 Actien-Gesellschaft für Monierbauten bearbeitet von F. Rehbein, Königil. Regier-ungs-und Baurath. Zweite vermehrte Auflage. Berlin 1894. Verlag und Druck von Julius Becker, Berlin S., Blücherstrasse 35.", and also a page of advertising, "Actien-Gesellschaft für Monier Bauten, vorm. F. A. Wayss & Co.," and also page 10 and plate VIII and page 20.

A. I have done so.

Q. 7. Please attach to your deposition a correct translation of the title page and other pages of the copy of the publication specified in the preceding question, and indicate on the drawing thereof a translation of the words thereon, in ink and pen, omitting measurements.

A.—

Translation of Rehlein 1894 *Publication.*

Title Page:

Selected

Monier and Concrete Constructions

Street and Railway Bridges

Superstructures, Silos, Sustaining Walls, Canals, etc.

Edited

On the Basis of Structures Erected by the Stock Company for Monier Constructions

by

F. Rehlein, Royal Government Councillor and Government Architect.

Second Enlarged Edition

Berlin, 1894

Printed and Published by Julius Becker, Berlin, S., 35 Blücher Street

252 The Stock Company for Monier Constructions
Formerly G. A. Wayss & Co.

Erection of Concrete Structures

A. Main Office and Central Technical Bureau:

101-102 Leipzig Street Berlin W. 101-102 Leipzig Street.
Equitable Building.

B. Branch Offices of the Same Firm:

Dresden, 3 Leupnitz St.	Copenhagen, 6 Linnesgade
Hamburg, 32 Gerhof St.	Königsberg, 5 Weidendamm
Hanover, 32 Ferdinand St.	Leipzig-Plagwitz, 67 Weissenfels St.
Cologne, 46 Hunnenrücken.	Witten on the Rhine.

C. Factories for Sewer Drainage Supplies, Sidewalks, etc.:

Rixdorf near Berlin, Königsberg, Leipzig-Plagwitz Gipsum Works and Factories for Gipsum Ceilings Niedersachswerfen near Nordhausen A. H.

D. Associated Company in Russia:

The Stock Company for Concrete and other structures, Moscow.

Telegraphic Address:
For A, B, and C: "Monierbau"
For D: "Beton."

Telegraphic Address:
For A, B, and C: "Monierbau"
For D: "Beton."

Rehbein p. 10, l 4ff.

If in the construction of the buttresses rammed concrete is used — a method that is to be highly recommended — the time consumed in the construction can be reduced still further.

The Monier process in combination with rammed concrete possesses, therefore, a number of properties and advantages that furnish engineers means of overcoming even great difficulties with relative ease.

This fact has come to be recognized by the Boards of Public Works more especially of Australia and Hungary. Recently also the Council of the City of Vienna has resolved to employ Monier arches in the construction of the Vienna City Railway, in order to take advantage, where streets pass under the railway, of the small structural height of these arches.

253 2. Culverts, Tunnels and Tubes.

The use of the Monier process of construction is very valuable in the case of a high pressure of water or earth against the crown or sole of culverts or of tunnels for passengers. By virtue of the advantages possessed by the material, indicated under 1. and 2., page 7 ff., the structure can very readily be given that (elliptical) sectional form which a rational line of pressure demands also for varying loads. The dangerous bending-strains also, that so easily result through careless back-pillars and putting on of the coating are effectively and securely met by the iron reinforcements, single or double according to need, reinforcements that in the case of less favorable building-ground are provided also in the sole of the structure. Here these are so arranged that, in keeping with the changing movement of flection, they lie on the train side, for it is evident that the sole, which distributes the pressure, is to be conceived as a beam with projecting ends which takes up the back-pressures directed from below to above. (Compare the drawing on Plate VIII.)

In accordance with this principle a large number of culverts have been built in Germany, Austria-Hungary, and also on the Great Venezuela Railway.

Remark. In spite of careful supervision of the execution and in spite of correct construction we know of a number of tunnels for passengers in railway stations that are not water-tight. The underground water puts in an appearance and troubles the passers-by. "This nuisance would not have arisen, if the principle of Monier construction had at the outset been applied and the sole been made secure against flection."

3. Monier Cappings in Factories, Granaries, etc. The Monier capping is also especially suited for roofs between iron girders in business houses, factories, granaries, etc.

254

Rehbein, P. 20. Running number.	Character of structure; number of openings.	Place and year of the execution.	Built for—	*a*) Width of span. *b*) Structural height from the impost to the top of the arch. *c*) Effective load. *d*) Height of the driveway above the top of the arch in meters, or number of kilograms or square meters.	Plate on which illustrations are to be found.	Remarks.
30	Street Bridge 1 Opening	Street between Ebhausen and Attensteig 1891	The Royal Württemberg Forestry Board	*a*) = 20.00 *b*) = 2.5 + 0.20 *c*) = heavy cylinders *d*) = 0.30	32	Testloads consisting of wagons weighing 8 tons. Foot paths of Monier plates on consoles. Buttresses rammed concrete.
31	Street Bridge 1 Opening	Bridge between Lübeck and Wakenitz 1893	The City of Lübeck	*a*) = 13.26 *b*) = 1.10 + 0.25 *c*) = heaviest wagons *d*) = 0.28		
32	Viaduct 3 Openings	Division Calbe Neugattersleben 1891	Royal Railway Directory Frankfort A. M.	*a*) = 10.0, resp. 7.8 *b*) = 1.0 + 0.10 resp. 1.7 + 0.10 *c*) = heaviest vehicle *d*) = 0.30, resp. 0.80		
33	Tunnel for pedestrians 1 Opening	Division Gera-Pforten-Nünckendorf 1891	Royal Saxon State Railway	*a*) = 3.12 *b*) = 0.30 + 0.11 *c*) = heavy machinery *d*) = 0.50		

34	High Road Bridge 1 Opening	Buddenbrock near Gereifenhagen 1891	Municipality Buddenbrock	$a) = 4.75$ $b) = 1.50 + 0.08$ $c) =$ heavy vehicle $d) = 0.30$	8
35	High-Road Bridge 1 Opening	Oliva near Danzig	Provincial Board	$a) = 4.80$ $b) = 0.80 + 0.07$ $c) =$ heavy vehicle $d) = 0.45$	

255 *Translation of Article by Planat, Sept. 22, 1894.*

Ninth Year.

La
Construction Moderne.

Weekly Illustrated Journal.

P. Planat, Director.

Art, Applied Theory, Practice.

Civil Engineering, Building Industry.

Paris.

Aulanier & Co., Editors.

13, Rue Bonaparte, 13.

1893–1894.

Translation of Article by Planat, 22nd Sept., 1894.
La Construction Moderne.

Theory of Reinforced Cement.

(See Page 597.)

Retaining Walls.

We have no knowledge that reinforced cement has been yet ap
plied to the construction of retaining walls. It would find there
however, an advantageous use. Walls of masonry have a volum
alone;
very considerable, since they resist pressure by their mass ∧ a mas
rigid and elastic can necessarily have dimensions much more con
stricted and there may result a very sensible economy. Iron would
have the same advantages but the metal employed would not be con
served in contact with the earth as well as iron buried in the cemen
an
where it has the valuable property of remaining for ∧ indefinit
time without any alteration.

We go then to indicate how calculations for a retaining wall may b
established. Let there be a wall to erect (Fig. 1), of a height *h* wit
a fill on the interior; we suppose this wall prolonged at its lowe
slab
part by a horizontal base ∧ A B for the purpose of maintainin
equilibrium.

256 The pressure H on the plane M A can be represented b

$\frac{Kh_2\S}{2}$, the density of the earth being §, and the coefficient K varying with the natural slope of the earth; this coefficient as we know can vary between limits very extreme according to the nature of earth from one tenth to one half in extreme limits. At K acts the weight P of the earth which is $lh\S$, if l is the breadth of the base A B.

It acts at the middle of the distance comprised between the plane M A and the interior face of the wall, that is to say, nearly at the middle of the interval l if one brings in the weight of the wall itself.

For further simplicity we neglect this which is an element favorable to stability.

After H and P are expressed one sees that the distance E D, between the point through which the weight P acts and the point where the resultant cuts the base, is expressed by

$$E\ D = \frac{H\ h}{3\ P} = \frac{K\ h_2}{6\ l} \qquad (1)$$

since the pressure H acts at the third of the height of h.

On the base A B the weight P exerts a uniform pressure the reaction of the soil (Fig. 2) on the lower face of A B is represented by a variable pressure from a point M where it is zero up to D where it attains its maximum value. The total resultant ought to be applied at the same point D through which passes the oblique resultant of the forces acting on the upper part.

If we consider the vertical part of the wall alone we see that the moment on B equals $H \times \frac{h}{3}$, or $\frac{K\ h_2\ \S}{6}$, according to value of H.

If we consider on the contrary the horizontal base we see that the moment of flexure at the extremity B will be:

$$r = \frac{P\ l}{2} - P\left(\frac{l}{2} - E\ D\right) = P \times E\ D = \frac{K\ h_2\ \S}{6} \qquad (2)$$

following the expression of P and of E D. These two expressions for the maximum moment on each of the two parts of the wall are equal as should be the case the piece being continuous.

257 It is the value of this moment that determines the dimensions of the wall at B and the neighboring region. Ought we to take as the useful thickness 2 *ro* 1/3 or 1/5 n, the third or the fifth of n, for that is the question which it is always necessary to answer in the beginning?

In the case of the vertical part a cantilever span above its point of

fixation B and loaded with a decreasing pressure we know that the fraction 1/5th should be adopted.

For the horizontal part let us see how the polygon of resulting forces presents itself; let us decompose the weight P into five equal parts, and let us construct in the usual manner, the corresponding polygon (Fig. 4); let us decompose the reaction of the soil into five forces, regularly increasing (Fig. 5), and let us trace the corresponding polygon with the same base as the preceding; the moments at each point will be measured by the differences of the ordinates taken on these two figures, and the resulting polygon is that of Figure 3. One sees that we have here presented a mixed case, intermediate between that of a polygon or curve corresponding to a case of uniform load on two supports, one which is characterized by a horizontal tangent at the summit, and that of a curve corresponding to a decreasing load, on a cantilever span, or corresponding to a single load, in which case the polygon meets the summit with an inclined tangent.

This should be so, since we have here two systems of loading on a cantilever span, the one uniform, the other decreasing, but in direction the one contrary to the other, opposed and compensating in part. It will be then proper to adopt in this case a fraction intermediate between 1/3 and 1/5, which will be 1/4, for instance; but as the two parts of the piece have a common section at B, it is the vertical part giving the smaller fraction which ought to control the section at B and in the neighborhood.

These preliminaries having been established, we have only to calculate the retaining wall like a reservoir wall; however, it remains for us to determine the length l of the horizontal base slab, and that upon the condition that the soil shall not be loaded with a greater working pressure than R, fixed in advance according to the nature of the soil.

258 Per running meter, the length N B of contact is 3 B D, the surface S which rests on the soil is $1.00 \times 3\ B\ D$ or $\frac{3\ l_2 - K\ h_2}{2\ l}$ following the value B D which is $l_2 - E\ D$.

The working compression on the soil is $\frac{2\ P}{s} = R$, from which one concludes:

$$l = h \times \sqrt{\frac{K\ R}{3\ R - 4\ h\ d}} \qquad (3)$$

All these elements are thus determined. Let us apply this method to a particular case.

Application:—Let there be a wall 4 meters high; the earth to be retained is of average quality, and one can give to K a value of 0.30 meters; its density is 1600 Kg per cubic meter.

The pressure H is $\frac{K\ h_2\ d}{2}$ or $\frac{0.30 \times 16 \times 1600}{2}$. Let it be 3340 Kg. The unit pressure at the base of the vertical wall is $\frac{2\ H}{h}$ or $\frac{6680}{4}$; let it be 1670 Kg.

(1) Slab—Let us take at the lower part a portion of the wall 1 meter high; the pressure there is less than 1670 x 3 or 5010 Kg. if we space the ribs 3 meters apart; the moment of flexure is 5,000 x 3/8″ or 1880, since the span is 3 meters.

Let us suppose n equal to 0.24 meters; one has taken here the fraction 1/3, for the load is uniform:

$$n=0.24\text{m}.\quad 2Vo=\frac{0.24}{3}=0.080.\quad d=0.240-\frac{0.080}{3}=0.173.$$

The total tension on the iron bars is:

$$T=\frac{1880}{0.173}=10{,}860,\ \text{from which}\ w=\frac{10{,}880}{8}=1360^{\text{m}}/\text{mq}.$$

Such is the section to distribute between horizontal bar placed in the height of one meter in the lower part if the value given n is sufficient.

The working stress in compression on the cement is $\frac{2 \times 10860}{0.080}$ or 27.1 kg; one will take them for n; 0.25 meters to 0.26 meters, for example, if one does not wish to exceed a working stress of 25 Kg; the total thickness will be about 3/10 of a meter.

259 (2) Rib—The relation (2) gives us a moment of flexure for the total piece which is $\frac{K\ h_2\ \$}{6}$ or $\frac{0.30 \times 64 \times 1600}{7}$; let it be 5120.

Suppose n equal to 8/10ths meters; one has, with the fraction 1/3:

$$n=0.80.\quad 2Vo=\frac{0.80}{5}=0.16.\quad d=\frac{0.160}{3}-0.053=0.747.$$

$$T=\frac{5120}{0.737}=6850.\quad w=\frac{6850}{8}=856^{\text{m}}/\text{mq}.$$

The compression on the current is $\frac{2 \times 6850}{3.00 \times 0.16}$ or 28.5 Kg; the

value of n will be about 0,85 meters and the total thickness comprised in the projection of the rib and the slab will be 0,95 meters for example.

It is easy to see that the cubical contents of ordinary masonry horizontal would be much greater. For the base slab A B its dimensions are all determined since the section necessary at B is known.

As we have indicated in the preceding one can reduce these sections on the vertical wall as well as on the horizontal base slab beyond the region which ought to be considered as dangerous—that is to say beyond the region where the breaking down of the cement is produced and the middle parts where the bars of the rib take their points of bedding and their gripping. Now, one knows that in the case where the polygon ends obliquely at the summit we are obliged to count only a very much reduced height of useful cement, since it decreases to one fifth of n; but that on the contrary the dangerous region has much less length than in the case of the uniform load or of a polygon or curve of horizontal tangency at the summit; one recalls that the tangent oblique at the summit cuts then the axis of the bars at about 1/5th of the half span; the curve itself ought to cut the axis of the bars at a distance not much more than 1/5th of the half span.

It follows that one should preserve the calculated proportions along a length at least equal to 1/5th of h or of l; beyond one can reduce the sections progressively; as we have already observed the
260 cement and the iron operating with integrity when one has passed this dangerous region, there is no longer any reduction to be made on the total section comprising the iron and the cement, for it has only compressive forces; the section may then be without inconvenience proportioned to the moment of flexure as in an ordinary piece and decreases as the moment itself decreases.

(To be continued.)

P. PLANAT

Translation of Article by Planat, Sept. 26, 1896.

Tenth Series—First Year.

Eleventh Year of the Collection.

La
Construction Moderne.

Weekly Illustrated Journal.

P. Planat, Director.

Art, Applied Theory, Practice.

Civil Engineering, Building Industry.

Paris.
Aulanier & Co., Editors.
13, Rue Bonaparte, 13.
1895–1896.

Translation of Planat Article La Construction Moderne—
September 26, '96.

Consultations on Technical Matters.

Quay Wall in Reinforced Concrete.

For the sanitation of the city of A diverse systems have been projected, but the only one adopted by the Government is that in which everything is carried in a sewer and turned into the sea. All of the sluice waters of the city are brought down by gravitation in a general collector established on the bank of the East Port and empty outside of the limits of this Port. Finally a quay is projected the entire length of the East Port for the sanitation of that side and the protection of the collector.

261 The profile type proposed for the quay is as follows:

The quay rests on two artificial blocks of concrete superposed, three meters of breadth and one and half meters in thickness. The higher block is raised a half meter above the level of the low tide. On these two blocks will be raised the quay wall proper, two meters thick at the base and with a vertical interior face; it will be surrounded by a parapet 7/10ths thick and one meter high. The exterior face will be of cycloidal form or better for more easy execution a rectilinear profile, either inclined or with easy angles, to approach the form of a cycloid. The body of the wall will be of ordinary hydraulic masonry with a face of stone of hard quality from Cairo or Europe.

The foundation blocks rest according to the case, either on the natural soil graded by drags to a convenient depth and consolidated if there is need of it by stones in those places where there is not a sufficient resistance or else by massive stones levelled to the bed desired when the elevation of the soil will be too low to permit the blocks to be seated directly.

A mass of rocks raised to the level of low tide with a beam of one meter wide and a slope inclined two of base to one of height will be supported against the blocks.

The above being stated I permit myself as a subscriber to your esteemed Journal to submit to you the following questions:

(1) Can the dimensions of the profile type above be reduced by the interpolation of bars, and thus a new profile-type of different form be adopted according to your learned theory of reinforced concrete?

(2) What will be the calculation to determine the diameter of these bars?

(3) Will it be practicable to construct the quay of artificial blocks of reinforced concrete each block having a form of a new profile type.

(4) What will be the economy realized by these modifications.

Response: Several data are wanting for an exact response to our correspondent. For example, we do not know what reason, without doubt, very plausible, why the thickness of the wall and the foundation are so great.

262 Thus, let us imagine in O M the natural slope of the earth made very mobile and capable of giving rise to a great pressure; and in O C the bisector as usual in O C D the angle φ and let us measure A D.

For the total height of 5.50 meters the pressure applied at the third of this height will be $\frac{5.50^{m} \times 1600^{k}}{2} \times 2.15^{m}$, or 9,460 kilograms. For the wall itself with a height of 2.5 meters the pressure will be $\frac{2.50^{m} \times 1600^{k}}{2} \times 1.00$ or 2,000 Kg.

The weight of the wall alone with the parapet will be 10,615 Kg approximately, by reason of 2,200 Kg per cubic meter, adding the weight of the concrete estimated at 2,500 Kg, the total weight is 33,115 Kg. Composing the partial weight and the partial pressure, the total weight and the total pressure, one sees that the resultants depart very little from the vertical, and that the stability as well as the resistance of the material are more than well secured.

Should one fear the pressure of the waters or some other cause demanding great thickness? We are ignorant of this. We will limit ourselves by indicating the process to follow in determining the elements of construction.

Let us adopt for example, a pressure of 10,000 Kg in round num-

bers of which the moment, around the base, is $\frac{10{,}000 \times 5.50^{m}}{3}$ or 18,335; let us admit that the retaining wall ought to descend even to this level without reducing the height on account of the horizontal base slab which ought to accompany the wall. Let us determine the minimum breadth of this base slab. Let L be this breadth; it is loaded with the weight of 5.50 1 x 1,600 Kg which ought to equilibrate the pressure. Its moment is after multiplying by $\frac{1}{2}$: $2.75\ l_2$, and should be equal to 18,335. From which it is concluded that the slab ought to have a breadth at least equal to 2.05 meters.

Let us suppose at first that the section of the wall down to the base of the foundation is constant.

(1) With a coefficient of security equal to 1/10th the value of n will be $0.00632 \sqrt{18{,}335}$ or 0.853 meters. The total thickness of concrete at the base, adding some centimeters for the embed-
263 ment of the bars, will then be 0.90 meters to 0.92 meters. One will maintain this thickness for a certain height, for example, one-fourth of the height, since one will diminish this progressively to the summit.

On the base slab the moment of flexture is the same; one will then furnish the same section.

section

The $\wedge$ total of the bars per running meter will be $19.7 \sqrt{18{,}335}$ or 2660 square millimeters. If one places five bars spaced 0.20 meters, the section for each will be 532, and the diameter will be 26 millimeters.

(2) If one is content with a coefficient of security of one fifth, an extreme limit, the value of n becomes $0.0041 \sqrt{18{,}335}$ or 0.551 meters; the thickness of the base is about 0.60 meters.

The total section is $32.4 \sqrt{18{,}335}$ or 4,375; with five bars per running meter, the diameter is 33 millimeters.

All these values will be reduced if the height of 5.50 meters is reduced by the thickness given the slab.

These computations suppose that one has effectively realized the fixing of the vertical wall to the horizontal slab at their junction. This fixing requires special precautions.

The bars at the point of junction exert a pulling force which tends to pull them out of the concrete. In a piece placed on two supports the tension to the right is balanced by a tension to the left on the same bar. But here we have only a half beam on a cantilever span. It is necessary that the extremities of the bars in the region of fixation should be held in a sufficient mass of concrete or maintained by some other means.

If the bar should be held only by adherence in the concrete it would be necessary for this holding to give it a great length. Let r be the radius of a bar which has a working stress of 8 Kg per square millimeter; its cross section is $T\ r_2$; its perimeter is $2\ T\ r$; let 1 be its length of embedment.

Let us admit that the resistance due to the bond may be about 30 kg per square millimeter; let us take, as a factor of safety, 1/10, or 3 Kg per square millimeter. The resistance will be 2 T rl x 3 x 10.

The tensile force is T r$_2$ x 8 1 x 10. Placing these equal to
264 each other, one sees that the length l ought to be at least equal to 133 r.

With a security of 1/5, the length will be 67 r.

From the values obtained above, one sees that it will vary from 0.017 x 67 or 1.20^m, to 0.013 x 133 or 173^m. It is necessary, therefore, that the base slabs or sill should project largely from the wall, and that this should descend notably below the base slab.

One is able to reduce these projections in a very large measure if one takes care to bind together the vertical bars and the horizontal bars at their point of intersection. In this way the pull of the bar is carried not only on its prolongation, arranged for anchorage, but also on the bar which is perpendicular to it and whose great length permits it to offer a large resistance to the force tending to pull it out transversely.

In constructions of this nature it is evidently the fixation which exacts all the attention of the constructor. One can, however, consolidate it also by means of some bars placed at 45 degrees in the dangerous angle and embedded in the two perpendicular walls.

In place of a wall of constant section one can arrange projecting ribs. Applying the first method we have indicated, it is easy to see that it will give the same results as the preceding calculation. If b is the spacing of the ribs, the moment u per running meter be-

comes here $u' = bu$, and the expression $\sqrt{\frac{u'}{b}}$ remains finally

equal to $\sqrt{u}$. The value of n is then the same as in the preceding case.

The value of w, cross-section of irons in the width b, will be proportional, not now to u, but to bu, which ought to be so, since, in reality, we concentrate in certain large bars, lodged in the rib, all the bars established in the width b.

One knows that, in this case, the spacing of the rib is

$\frac{2\ 1}{2}$ or $\frac{2\ 1}{2.5}$ when the load is uniform; the length l being 5.50

meters, one can admit that this spacing ought to be about 4 or 5 meters. Let us adopt 4 meters.

The total thickness at the rib will be as in the wall of constant section, from 9/10ths to 0.92 meters with a security of 1/10;
265 about 6/10ths meters with a security of 1/5th. The total section of the irons will be 4 x 2,660 or 4 x 4,375 square millimeters to divide among some large bars placed in the rib.

The thickness of the wall between the ribs will be notably reduced,

the value of ho $= 0{,}00346 \sqrt{18{,}335}$ or $0{,}422^{m}$ with a security of 1/10th; the thickness will be 0.48 meters for example. With a security of 1/5th the value of ho $= 0{,}00274 \sqrt{18{,}335}$ or 0.37 meters and the thickness of 0.42 meters for example.

further

Finally one can as we have said modify xxx ^ the thickness of the wall and further reduce it in increasing the projection of the ribs. For calculating this if one wishes to adopt this system one will follow the third method that we have indicated. One will find there economy in metal and concrete.

We will recall to our correspondent if he wishes to employ reinforced concrete it is very important to only load the construction as late as possible. That is to say after a month at least. Without this one exposes oneself to disagreeable consequences. Above all the setting and the adherence are very imperfect.

P. P.

266 *Patent Office Translation of Bauzeitung Article.*

(Patent Office Translation of the Bauzeitung Article. Printed Record, p. 56.)

United States of America,

Department of the Interior.

United States Patent Office.

To all to whom these presents shall come, Greeting:

This Is To Certify that the annexed is a photographic copy of an Article, with illustration, beginning on Page 621, Issue of December 15, 1894, Number 100, of a Publication in the Library of this Office entitled:—

Deutsche Bauzeitung.

Verkundigungsblatt des
Verbandes Deutscher Architeken—und
Ingenieurvereine

Achtundzwanzigster Jahrgang.
1894.
Berlin.

Attached, hereto, is a true copy of a Translation made by the Official Translator in the matter of the same.

Said Issue having been received in the Scientific Library of this Office December 29, 1894.

In Testimony Whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington,

this 3rd day of September, in the year of our Lord one thousand nine hundred and fifteen and of the Independence of the United States of America the one hundred and fortieth.

[SEAL.] J. T. NEWTON,
Acting Commissioner of Patents.

267

Translation.

From Deutsche-Bauzeitung, 1894, pp. 621 and 622.

Empirical Tests in Civil Engineering.

Especially Breaking Load Tests of Reenforced Concrete Structures.

(Conclusion.)

(*d*) Angular retaining wall, held in position by means of concrete ground anchors.

This retaining wall, on which a "Gebrauchsmusterschutz" (utility model patent) has been granted, consists of a vertical and a horizontal member. These two members are rigidly connected with each other. The ratios are so chosen that the resultant of the earth thrust passes through the horizontal part or through the foundation respectively, so that there exists no longer any tendency to tilting so long as the two parts continue to be firmly connected with each other. To increase the stability, the horizontal part is furthermore connected at its rear end by means of anchors with the underground.

The rigid connection of the two parts may be effected either, as shown in fig. 25, by continuing the anchors in the masonry or in the concrete of the piles located at the rear, or, as shown in fig. 28, by enlarging both parts at their joint angle. Of the two methods of construction, the former one, with iron anchors, is to be specially recommended on account of its greater safety.

Test of the Angular Retaining Wall.

On June 30 of the present year, the load test of the thin experimental walls illustrated in figs. 25 and 28 was made in the presence of several members of the Ingenieur-Verein (Society of Engineers) of this city and of the Technical High School, as also of Architect Ingwersen, who had been kindly delegated by the Superintendent of River & Harbor Construction in Hamburg upon an invitation extended by us to the Superintendent, and of Government Architect Franck, President of the Railway Construction Division "Altona" of the firm of Lenz & Co.

The two retaining walls A and B were erected during the latter part of the summer of 1893. The mixture consisted of 1 part of cement, 3 parts of sand, $1\frac{1}{2}$ parts of Hartz crushed gravel
268 and $1\frac{1}{2}$ parts of Gabbro ballast. But owing to the extreme thinness of the walls the stone material used had to be too fine, which impaired the breaking strength of the concrete.

The iron anchors used consisted of only 3 and 7-mm. wires respectively. The intention was to have the iron anchors of sufficient strength to insure, as far as the iron was concerned, a single factor of safety, with the wall fully filled in at the rear. But the test showed that, owing to the breaking strength of the concrete, a further load had to be added. This was put outside on a wooden bracket shown in dotted lines (see figs. 25 and 28.)

The wall A showed a defect. The piles had been made first, and then only had the vertical wall been erected. But the latter no longer combined with the piles, which had already set, so that a perpendicular crack occurred here. The connection was imperfect and had been secured only at the ribs.

The first load test began December 22, 1893. Up to January 15, 1894, both walls were left completely filled in at the rear. They withstood the pressure but inclined slightly forward. This is probably due chiefly to the insufficient foundation. All that had been done was to remove the upper 30cm. layer of soil of the existing ground and erect the wall on the latter. This first test showed that the simple dead load of the back filling does not produce the maximum stress. On the other hand, the alternation of frost and thaw, of rain and drought produces greater stress, so that the walls during the time stated continued to incline forward, in all fully 1 cm. The temperature during this period had fluctuated between thaw and 17° C. below zero.

After the bottom of the back filling (gravel) had been removed the two retaining walls showed no injuries.

The Place of Rupture.

The rupture occurred, with a load on the bracket, at a total load of 1335 kg. The moment of this load increases linearly downward beginning at the crown, reaches a maximum at the lower end of the boards at P, and below that to the foot of the wall it remains 269 constant at 688 mkg. This is the moment of the bracket load Q, which strikes the entire wall of 3 m. length (see fig. 27).

The moment of the earth thrust begins at the crown of the wall also with zero value. But as the earth thrust increases downward proportionately to the height, the moment of the earth thrust increases according to the third power (See dotted curve abcd, fig. 27). Hence, in the upper part of the wall the moment of the bracket load is greater, and in the lower part the moment of the earth thrust. The bracket load produced a total moment which exceeded that of the earth thrust several times at the top, but at the foot of the wall by only 4/3 of the moment of the earth thrust. The most endangered part, in view of the compound load used, was thus the upper part, and therefore the walls did not break at the foot but some distance above it, the wall A just above the reinforcing rib of the second anchor.

Breaking Strength of the Wall A with Iron Anchors.

At the place of the rupture (see figs. 25 to 27) just above the middle rib the moment of the stress of the bracket load was M_1 = 500 mkg. This moment is calculated as follows:

The total moment of the bracket load is 1335. 0,525 mkg.; this is equal to K . 1,53 m., K designating the horizontal force produced by said bracket load at the crown of the wall, and the number 1,53 designating the lever arm of the force K relative to the foot point of the bracket.

$$K = \frac{1335 \text{ kg.} \,.\, 0,525 \text{ m.}}{1,53 \text{ m.}} = \frac{688 \text{ mkg.}}{1,53 \text{ m.}} = 450 \text{ kg.}$$

At the point of the rupture, just above the middle rib, K has a lever of 1.11 m. Hence the moment sought is

M_1 = 1.11 m. . 450 kg. . . . . = 500 mkg.
In addition M_1 moment of the earth thrust at that point (δ, angle of slope of the rear filling-in, assumed to be 35°) . . . . . = 231 "

Total M . . . . . = 731 mkg.

At the point of the rupture the moment of the stress was 731. 231 = 3,1 times the moment of the earth thrust at that point, so that the wall here resisted the earth thrust with a factor of safety of 3,1. (Thickness of wall and ribs 5 cm.)

The breaking stress of the concrete of the pile ribs is calculated as follows: Let it be assumed that at the time of the rupture the strain of the elastic iron of the anchor was only 1000 kg., so that the concrete was ruptured first and then the iron of the anchor.

270

The cross-section of the two 3 mm. anchor wires was in all about 0,16 sq. cm.; the strain of the same was therefore 0,16 . 1000 = 160 kg. The moment of this strain is calculated in Mc.

Mc = 160 kg. . 0,36. = 57,6 mkg.

The moment of stress was . . . . . M = 731,0 mkg.
The two anchors absorbed . . . . . Mc = 57,6 "

Hence there remained for the concrete piles . . . . $\frac{1}{2}$ Mb = 673,4 mkg.

As the two piles were not firmly connected with the vertical wall the moment of resistance can not be determined accurately. Leaving the vertical wall entirely out of the calculation, the moment of

$$\text{sistance} = \frac{2\,b\,h^2}{6} \,.\, S.$$

$$2 \,.\, \frac{5 \,.\, 45^2}{6} \,.\, S = 67340 \text{ cmkg.}$$

$$S = \frac{67340 \,.\, 6}{2,5,45,45}$$

$S =$ in round numbers, 20 kg.

As the wall can not be neglected, S must in reality have been less than 20 kg. but more than 10 kg., so that we have as a mean value for the concrete of the piles a breaking strength of about 15 kg.

Breaking Strength of the Wall A without Iron Anchors.

(See Figs. 27 and 28.)

The walls A and B were intended to withstand forces of equal magnitude. Accident would have it that the fracture of the two walls occurred with exactly the same load, so that fig. 27, showing the moments of stress, is applicable here also.

The fracture of the wall occurred exactly where the wooden bracket stopped. That point was in this case, as determined above, the most endangered one.

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The amount of stress of the bracket load was..... $M_1 = 688$ mkg.
The moment of stress of the thrust of the earth at the point of fracture..... $M_2 = 635$ "

Total moment ..... $M = 1323$ mkg.

At the point of fracture the wall had a thickness of 16 cm.
Hence

$$\frac{b\,h^2}{6} \,.\, S = 1323 \text{ mkg.}$$

$$\frac{300 \,.\, 16 \,.\, 16}{6} \,.\, S = 132300 \text{ cmkg.}$$

$$S = \frac{132300 \,.\, 6}{300,16,16}$$

$$S = 10,3 \text{ kg.}$$

It must be admitted that this breaking strength is exceedingly low. It is possible however, that the earth thrust was in reality greater than assumed in the calculation; but on the other hand it is likewise

possible that the broken stone used for these very thin walls and which was too small reduced the breaking strength. But the chief reason I should ascribe to the fact that we have to do with a fracture along the ramming joints. The different horizontal layers in concrete probably do not combine as well as the mass of one layer in itself. In that case, as in wrought iron, the strength is lower transversely to the rolling grain, so in the case of concrete when the stress is transverse to the different layers we may have to reckon with lower breaking strength in special cases. This question will have to be answered by tests.

Result of Tests.

We may say, nevertheless, that the result of the tests has been very satisfactory. The experimental walls fully resisted the earth thrust with a factor of safety of 2, so that with walls twice as thick the factor of safety against rupture would be 8. But the walls anchored with iron would probably be preferable because the breaking strength of the concrete may occasionally drop to a lower value. An angular retaining wall anchored with iron is a very solid structure, especially when by means of concrete ground-anchors or other method of anchoring it is given a higher moment of resistance
272 against tilting than can be obtained in the case of ordinary walls. With a factor of safety of 8 against rupture, a retaining wall 2.2 m. high would require only 10 cm. thickness of concrete—i. e., 1.22 of the height or 1.7 of the usual thickness of solid masonry walls. While some further expense must be added for piles and iron anchors, it is nevertheless, obvious that a saving is effected. On the other hand, with the same amount of money an angular retaining wall could be built having a higher factor of safety than an ordinary unanchored retaining wall.

Comparison of Cost.

An angular retaining wall 2.2 m. high requires for a running meter about:

0.4 cub.m. of concrete of best mixture, at 40 M. each	M. 16.0
8 kg. of iron per running meter, at 20 pf	1.6
Total, without earthwork, etc	M. 17.6

A solid masonry retaining wall of the same height and of a mean thickness of

$$\frac{h}{3} \quad \frac{2.20}{3} = 73 \text{ cm.}$$

requires 1.6 cub. m. of brick masonry in cement mortar, at M. 22 per cub. m. M. 35.2

Thus, the construction of an angular retaining wall, aside from the earthwork, is only about one-half as expensive as a solid masonry wall, allowing for four times as much iron and twice as much concrete material as used in the experimental walls.

(Endorsed:) #459. Stipulation with exhibits attached. Filed Feb. 8, 1917. Edward M. Holloway, Clerk.

273 United States Circuit Court of Appeals for the Seventh Circuit.

I, Edward M. Holloway, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing printed pages, numbered from 1 to 272, inclusive, contain a true copy of the printed record, printed under my supervision and filed January 30, 1917, on which this cause was argued, heard and determined in the case of Frank A. Bone vs. Commissioners of Marion County, No. 2459, October Term, 1916, as the same remains upon the files and records of the United States Circuit Court of Appeals, for the Seventh Circuit.

In testimony whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this fourth day of February A. D. 1918.

[Seal United States Circuit Court of Appeals, Seventh Circuit.]

EDWARD M. HOLLOWAY,
Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

274 At a Regular Term of the United States Circuit Court of Appeals for the Seventh Circuit, Begun and Held in the United States Court-room, in the City of Chicago, in said Seventh Circuit, on the Third Day of October, 1916, of the October Term, in the Year of Our Lord One Thousand Nine Hundred and Sixteen and of Our Independence the One Hundred and Forty-first Year.

And afterwards, to-wit: On the nineteenth day of January, 1917, in the October term last aforesaid, came the appellant, by his counsel, Mr. Arthur H. Ewald, Mr. Oliver W. Sharman and Mr. Clarence E. Mehlhope, and filed in the office of the Clerk of this Court their appearance, which appearance is in the words and figures following, to-wit:

In the United States Circuit Court of Appeals for the Seventh Circuit.

2459.

FRANK A. BONE, Appellant,

vs.

COMMISSIONERS OF MARION COUNTY, Appellee.

Bone Patent No. 705,732.

Clerk United States Circuit Court of Appeals, Seventh Circuit, Cincinnati, Ohio.

SIR: You will please enter our appearance as counsel for
275 Plaintiff-Appellant, in the above entitled cause.

Dated, Cincinnati, Ohio.

ARTHUR H. EWALD,
OLIVER W. SHARMAN.

Address 816 Mercantile Library Bldg., Cincinnati, Ohio.

Dated, Chicago, Illinois.

CLARENCE E. MEHLHOPE.

Address 808 Marquette Bldg., Chicago.

Endorsed: Filed Jan. 19, 1917. Edward M. Holloway, Clerk.

And afterwards, to-wit: On the first day of February, 1917, in the October term last aforesaid, came the appellees, by their counsel, Mr. V. H. Lockwood, and filed in the office of the Clerk of this Court his appearance, which appearance is in the words and figures following, to-wit:

United States Circuit Court of Appeals for the Seventh Circuit.
October Term, 1916.

No. 2459.

FRANK A. BONE, Appellant,

vs.

COMMISSIONERS OF MARION COUNTY, Appellees.

The Clerk will enter my appearance as counsel for the Appellees.

V. H. LOCKWOOD.

Endorsed: Filed Feb. 1, 1917. Edward M. Holloway, Clerk.

276 And afterwards, to-wit: On the fifth day of February, 1917, in the October term last aforesaid, there was filed in the office of the Clerk of this Court a certain Objection to Transcript and Printed Record and Motion for Completion of Transcript and Printed Record, which Objection and Motion are in the words and figures following, to-wit:

In the United States Circuit Court of Appeals for the Seventh Circuit.

No. 2459.

FRANK A. BONE, Appellant,
vs.
COMMISSIONERS OF MARION COUNTY, Appellee.

Objection to Transcript and Printed Record.

To Clerk of U. S. Circuit Court of Appeals for Seventh Circuit:

Comes now the appellee, by its counsel, and objects to the incompleteness of the transcript and printed record filed in the above entitled cause by the appellant, and says that said transcript and printed record have omitted *in* the following items and parts of the defense specified in the pracipe which should be included in the transcript on page 174 of the record and a stipulation on page 176 which called for the printing of the translations:

5. Deposition of Dr. Vos and copies of the publications therein.

15. Copy of Judge Day's opinion from the record of the
277-78 U. S. 6th Circuit Court of Appeals.

17. Translation of Planat publications, 1894 and 1896, the foreign language to be omitted.

18. Translation of Bauzeitung article, the foreign language to be omitted.

Counsel further states that said transcript was never submitted for inspection or any notice or opportunity given to him to inspect the same, before it was filed.

V. H. LOCKWOOD,
Counsel for Appellee.

In the United States Circuit Court of Appeals for the Seventh Circuit.

No. 2459.

FRANK A. BONE, Appellant,
vs.
COMMISSIONERS OF MARION COUNTY, Appellee.

Motion for Completion of Transcript and Printed Record.

Comes now V. H. Lockwood, attorney for appellee in the above-entitled cause and moves the Honorable Court that the appellant be

required immediately to complete the transcript of the record and the printed record in accordance with the præcipe on page 174 and the stipulation of counsel on page 176 of the printed record, by including therein the following items specified in the præcipe, but which have been omitted from the transcript of the record and the printed record:

5. Deposition of Dr. Vos and copies of the publications
279 therein.

15. Copy of Judge Day's opinion from the record of the U. S. 6th Circuit Court of Appeals.

17. Translation of Planat publications, 1894 and 1896, the foreign language to be omitted.

18. Translation of Bauzeitung article, the foreign language to be omitted.

V. H. LOCKWOOD,
Counsel for Appellee.

Notice.

Ewald & Sharman, 816 Mercantile Library Bldg., Cincinnati, Ohio.
Counsel for Appellant.

DEAR SIRS: Notice is hereby given that the above motion will be filed immediately with the Clerk of the above Court and will be presented as soon thereafter as the practice and rules for such motions provide.

V. H. LOCKWOOD,
Counsel for Appellee.

280 In the United States Circuit Court of Appeals for the Seventh Circuit.

No. 2459.

FRANK A. BONE, Appellant,

vs.

COMMISSIONERS OF MARION COUNTY, Appellee.

Proof of Service.

STATE OF INDIANA,
County of Marion, ss:

Margery Alexander, being first duly sworn, deposes and says that on the 3rd day of February, 1917, she deposited in the Post Office at Indianapolis, Indiana, a true and correct copy of the Objection to Transcript and Printed Record and Motion for Completion of Transcript and Printed Record in the above cause, said copy being enclosed in an envelope addressed as follows:

"Ewald & Sharman, 816 Mercantile Library Bldg., Cincinnati, Ohio."

This envelope was sealed, stamped and registered, as shown by the attached registry receipt.

MARGERY ALEXANDER.

Subscribed and sworn to before me, this 3rd day of February, 1917.

[SEAL.] JULIA H. WELLS,
Notary Public.

Commission expires April 21, 1920.

(Registry Receipt is attached to original of this paper.)

Endorsed: Filed Feb. 5, 1917. Edward M. Holloway, Clerk.

281 And afterwards, to-wit: On the eighth day of February, 1917, in the October term last aforesaid, there was filed in the office of the Clerk of this Court a certain Stipulation with exhibits attached, which said Stipulation is not copied here, as the same appears upon page 245 of the printed record in this cause, certified herewith.

And afterwards, to-wit: On the tenth day of April, 1917, in the October term last aforesaid, the following further proceedings were had and entered of record, to-wit:

Tuesday, April 10, 1917.

Court met pursuant to adjournment and was opened by proclamation of crier.

Present:

Hon. Francis E. Baker, Circuit Judge, presiding.
Hon. Christian C. Kohlsaat, Circuit Judge.
Hon. Julian W. Mack, Circuit Judge.
Hon. Samuel Alschuler, Circuit Judge.
Hon. Evan A. Evans, Circuit Judge.
Edward M. Holloway, Clerk.
John J. Bradley, Marshal.

Before Hon. Christian C. Kohlsaat, Circuit Judge; Hon. Samuel Alschuler, Circuit Judge; Hon. Evan A. Evans, Circuit Judge.

2459.

FRANK A. BONE
vs.
COMMISSIONERS OF MARION COUNTY.

Appeal from the District Court of the United States for the District of Indiana.

282 It is ordered by the Court that this cause be and the same is hereby set down for hearing on May 3, 1917.

And afterwards, to-wit: On the third day of May, 1917, in the October term last aforesaid, the following further proceedings were had and entered of record, to-wit:

Thursday, May 3, 1917.

Court met pursuant to adjournment and was opened by proclamation of crier.

Present:

Hon. Francis E. Baker, Circuit Judge, presiding.
Hon. Samuel Alschuler, Circuit Judge.
Hon. Evan A. Evans, Circuit Judge.
Hon. George A. Carpenter, District Judge.
Edward M. Holloway, Clerk.
John J. Bradley, Marshal.

Before Hon. Samuel Alschuler, Circuit Judge; Hon. Evan A. Evans, Circuit Judge.

2459.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Appeal from the District Court of the United States for the District of Indiana.

It is ordered by the Court that this cause be, and the same is hereby re-set down for hearing on May 4, 1917.

And afterwards, to-wit: On the fourth day of May, 1917, in the October term last aforesaid, the following further proceedings were had and entered of record, to-wit:

283 Friday, May 4, 1917.

Court met pursuant to adjournment and was opened by proclamation of crier.

Present:

Hon. Francis E. Baker, Circuit Judge, presiding.
Hon. Samuel Alschuler, Circuit Judge.
Hon. Evan A. Evans, Circuit Judge.
Hon. Kenesaw M. Landis, District Judge.
Edward M. Holloway, Clerk.
John J. Bradley, Marshal.

Before Hon. Samuel Alschuler, Circuit Judge; Hon. Evan A. Evans, Circuit Judge; Hon. Kenesaw M. Landis, District Judge.

2459.

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Appeal from the District Court of the United States for the District of Indiana.

Now this day come the parties by their counsel and this cause now comes on to be heard on the printed record and briefs of counsel and on oral arguments by Mr. Clarence E. Mehlhope and Mr. Arthur H. Ewald, counsel for appellant, and by Mr. V. H. Lockwood, counsel for appellee, and the Court having heard the same takes this matter under advisement.

284 At a Regular Term of the United States Circuit Court of Appeals for the Seventh Circuit, Begun and Held in the United States Court-room, in the City of Chicago, in said Seventh Circuit, on the Second Day of October, 1917, of the October Term, in the Year of Our Lord One Thousand Nine Hundred and Seventeen and of Our Independence the One Hundred and Forty-Second Year.

And afterwards, to-wit: On the second day of October, 1917, in the October term last aforesaid, there was filed in the office of the Clerk of this Court the Opinion of the Court, which opinion is in the words and figures following, to-wit:

285 In the United States Circuit Court of Appeals for the Seventh Circuit, October Term and Session, 1917.

No. 2459.

FRANK A. BONE, Plaintiff and Appellant,

vs.

COMMISSIONERS OF MARION COUNTY, Defendant and Appellee.

Appeal from the District Court of the United States for the District of Indiana.

Alschuler and Evans, Circuit Judges, and Landis, District Judge.

Appeal from Decree Dismissing Bill Brought to Enjoin Infringement of Patent.

EVANS, *C. J.*:

Plaintiff sought damages, and an injunction to prevent future infringement of patent No. 705,732, issued July 29, 1902, upon

application filed April 22, 1899. The bill was dismissed upon a finding of no infringement.

The patent under consideration relates to a retaining wall of the cantilever type, and is described by the patentee as follows:

"My invention relates to improvements in retaining walls for abutments of bridges, seawalls, banks of streams, embankments, cuts, dams, dry-docks, and such places as it is desired to retain earth or other matter permanently in place with its face at an angle nearer vertical than it would naturally repose when exposed to the action of the elements or gravity. * * *

286 "The said invention consists principally of introducing into masonry of concrete, stone, or brick a framework of steel or iron in such a way that the whole wall is so much strengthened thereby that the volume of the masonry may be greatly reduced, and yet the height, base and strength against overturning, bulging or settling will still be ample."

Again he says:

"I am aware that retaining walls have been constructed of concrete and steel, but none to my knowledge (1) have been supported on their own base as mine, (2) nor have any of them entirely enclosed the steel within the concrete, (3) nor have any of them used the weight of the material retained as a force to retain itself."

Claims 1, 3, 5, 16 and 17 are involved in the present suit. Claims 1 and 16, which are typical, read as follows:

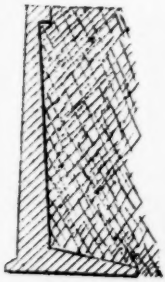
"1. The combination with a retaining wall having a heel, of a metal structure embedded vertically in said wall and obliquely in said heel, so that the weight of the retained material upon the heel of the metal structure will operate to retain the wall in vertical position."

"16. The combination with a retaining wall having a heel and a toe at opposite sides thereof, said toe having an independent metal structure embedded therein, of a metal structure embedded within said wall and heel, said structure consisting of upright bents at the back part of the vertical wall and continuing down along the upper part of the heel of said wall to the back part thereof, so that the weight of the retained material upon the heel of the metal structure will operate to maintain the wall in a vertical position."

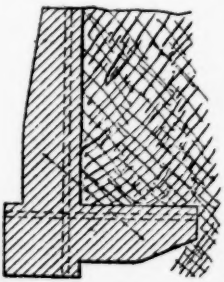
Defendant maintains: (*a*) that the patent is anticipated by the prior art; (*b*) if not so anticipated, the claims must be so restricted and construed as to support the finding made by the trial judge that there was no infringement.

The following drawings represent the plaintiff's wall, defendant's wall, and the prior art:

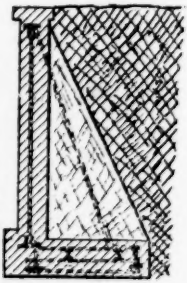
(Here follow drawings marked page 287.)



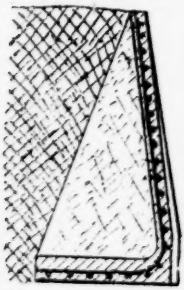
BAUZEITING-1894



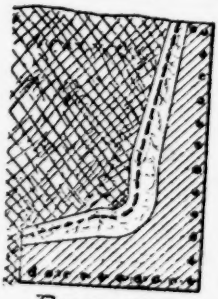
PLANAT-1896



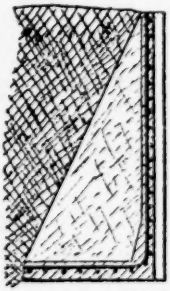
STOWELL & CUNNINGHAM-1897



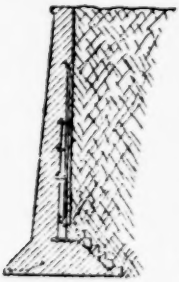
REHBEIN-1894

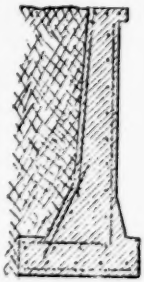


PLANAT-1894



MOLTHENIUS 1895





BONE-1899

MARION COUNTY

P. 287

These figures admirably picture the state of the prior art.

As early as 1869, a patent was issued to Francois Coignet, No. 457, covering the principle of reinforced concrete which was for e avowed purpose of "giving greater cohesive strength," so that ne walls or size of the articles may be considerably reduced." om that date to the date of the application for a patent by Bone, various retaining walls have been designed and constructed. s The Bauzeitung wall appearing in 1894, was of the cantilever type, with the heel and toe feature found in the Bone patent.

Two articles written by Planat appeared in the scientific magazine a Construction Moderne," a Paris publication, in 1894 and 1896, th deal with retaining walls of reinforced concrete of the cantilever pe. We quote from the article appearing in 1896:

"These computations suppose that one has effectively realized the ing of the vertical wall to the horizontal slab at their junction. is fixing requires special precautions. The bars at the point of nction exert a pulling force, which tends to pull them out of the ncrete. * * * But here we have only a half beam on a ntilever span. It is necessary that the extremities of the bars in e region of fixation should be held in a sufficient mass of concrete maintained by some other means.

"One is able to reduce these projections in a very large measure one takes care to bind together the vertical bars and the horizontal rs at their point of intersection. In this way the pull of the bar carried not only on its prolongation, arranged for anchorage, but so on the bar which is perpendicular to it and whose great length rmits it to offer a large resistance to the force tending to pull it t transversely."

On July 25, 1899, upon application filed March 25, 1897, a patent, o. 629,477, was issued to Stowell & Cunningham, covering a retain- g wall illustrated above. Further reference to the prior art seems rdly necessary.

Planat, as well as Bauzeitung, and Stowell & Cunningham each isclosed a wall with a heel in the base, while the toe appears in at ast four previous types illustrated by the drawings. It likewise early appears that the entire enclosure of steel by the concrete was ot original with Bone.

If there be any patentable novelty disclosed by Bone's wall, it is y reason of the location of the reinforcement. In fact this seemed be the patentee's own idea of the novelty, for he says:

"The said invention consists principally of introducing into asonry of concrete, * * * a framework of steel or iron in ch way that the whole wall is so much strengthened thereby that he volume of the masonry may be greatly reduced and yet the * * strength * * * will still be ample."

It is not necessary to decide whether the location of the reinforcement in the concrete in order to give greater strength in 1899 evidenced patentable novelty when applied to retaining walls,

289 for if the claims in this patent are so restricted and limited, it is obvious that defendant's wall did not infringe in this respect.

Our attention is called to the fact that this patent was sustained in the case of Bone v. City of Akron, 229 Fed. 944. An examination of the decision in that case shows that evidence of the prior art was not introduced, otherwise a different conclusion would have been reached. The court said:

"If the prior art had shown a structure intended for a retaining wall, and having a heel such that the weight of the earth thereon would tend to keep the wall erect, it might be difficult to find invention in merely adding the form of reinforcement most suitable to create the desired tensile strength; but we find no such earlier structure. Those which have that shape are sustaining walls only, and were so obviously unfit for use as retaining walls that no one seems to have seen the utility for the purpose, of which the form, when properly adapted and strengthened, was capable."

The learned district judge who tried this case in the court below aptly distinguished the facts in the present case from those disclosed in the opinion above quoted. He said:

"So the court did not have before it the evidence either on the petition for re-hearing or on the original hearing, that this court has, on the state of the prior art."

"He (Bone) was not the first person to reinforce a retaining wall; he was not the first person to conceive the idea of reinforced retaining wall which was so shaped and constructed that the weight of the earth on the heel of the wall would withstand the pressure of the dirt or the earth on the wall. He was not the first to do it. * * * Now it may be that on the record before Judge Day, Bone was the first person to do that. So far as the record in this case is concerned, the absolute converse of that proposition has been demonstrated."

With the claims restricted to a matter of location of the reinforcement (the validity of which we need not decide), there is no infringement.

The decree is affirmed.

A true Copy.

Teste:

_____,

Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

290 And afterwards, on the same day, to-wit: On the second day of October, 1917, in the October term last aforesaid, the following further proceedings were had and entered of record, to-wit:

Tuesday, October 2, 1917.

Court opened by proclamation of crier.

Present:

Hon. Francis E. Baker, Circuit Judge, presiding.
Hon. Christian C. Kohlsaat, Circuit Judge.
Hon. Samuel Alschuler, Circuit Judge.
Hon. Evan A. Evans, Circuit Judge.
Edward M. Holloway, Clerk.
John J. Bradley, Marshal.

Before Hon. Samuel Alschuler, Circuit Judge; Hon. Evan A. Evans, Circuit Judge; Hon. Kenesaw M. Landis, District Judge.

2459

FRANK A. BONE

vs.

COMMISSIONERS OF MARION COUNTY.

Appeal from the District Court of the United States for the District of Indiana.

This cause came on to be heard on the transcript of the record from the District Court of the United States for the District of Indiana, and was argued by counsel.

On consideration whereof, It is now here ordered, adjudged and decreed by this Court that the decree of the said District Court in this cause be, and the same is hereby affirmed with costs.

291 And afterwards, to-wit: On the twenty-sixth day of October, 1917, in the October term last aforesaid, there was filed in the office of the Clerk of this Court a certain Petition for Rehearing, which said Petition for Rehearing is not copied here nor made a part of this record.

And afterwards, to-wit: On the tenth day of November, 1917, in the October term last aforesaid, there was filed in the office of the Clerk of this Court a certain Answer to the Petition for Rehearing, which said Answer is not copied here nor made a part of this record.

And afterwards, to-wit: On the seventeenth day of December, 1917, in the October term last aforesaid, the following further proceedings were had and entered of record, to-wit:

Monday, December 17, 1917.

Court met pursuant to adjournment.

Present:

Hon. Francis E. Baker, Circuit Judge, presiding.
Hon. Christian C. Kohlsaat, Circuit Judge.
Hon. Samuel Alschuler, Circuit Judge.
Hon. Evan A. Evans, Circuit Judge.

Before Hon. Samuel Alschuler, Circuit Judge; Hon. Evan A. Evans, Circuit Judge; Hon. Kenesaw M. Landis, District Judge.

292 2459.

FRANK A. BONE
vs.
COMMISSIONERS OF MARION COUNTY.

Appeal from the District Court of the United States for the District of Indiana.

It is ordered by the Court that the petition for a rehearing in this cause be, and the same is hereby denied.

293 United States Circuit Court of Appeals for the Seventh Circuit.

I, Edward M. Holloway, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing typewritten and printed pages, numbered from 1 to 18 , inclusive, contain a true copy of the proceedings had and papers filed (except the briefs of counsel and stipulation relating thereto, the Stipulation with exhibits attached, filed February 8, 1917, which said Stipulation appears on page 245 of the printed record in this cause, the Petition for Rehearing and the Answer to same) in the case of Frank A. Bone vs. Commissioners of Marion County, No. 2459, October Term, 1916, as the same remains upon the files and records of the United States Circuit Court of Appeals, for the Seventh Circuit.

In testimony whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this fourth day of February A. D. 1918

[United States Circuit Court of Appeals, Seventh Circuit.]

EDWARD M. HOLLOWAY,
Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

294 UNITED STATES OF AMERICA, *ss:*

[Seal of the Supreme Court of the United States.]

The President of the United States of America to the Honorable the Judges of the United States Circuit Court of Appeals for the Seventh Circuit, Greeting:

Being informed that there is now pending before you a suit in which Frank A. Bone is appellant, and Commissioners of Marion County are appellees, No. 2459, which suit was removed into the said Circuit Court of Appeals by virtue of an appeal from the District Court of the United States for the District of Indiana, and we, being willing for certain reasons that the said cause and the record and proceedings therein should be certified by the said Circuit Court of Appeals and removed into the Supreme Court of the United
295 States, do hereby command you that you send without delay to the said Supreme Court, as aforesaid, the record and proceedings in said cause, so that the said Supreme Court may act thereon as of right and according to law ought to be done.

Witness the Honorable Edward D. White, Chief Justice of the United States, the sixteenth day of March, in the year of our Lord one thousand nine hundred and eighteen.

JAMES D. MAHER,
Clerk of the Supreme Court of the United States.

[Endorsed:] File No. 26352. Supreme Court of the United States, October Term, 1917. No. 885. Frank A. Bone vs. Commissioners of Marion County. Writ of Certiorari. Filed Mar. 23, 1918. Edward M. Holloway, Clerk.

296 In the United States Circuit Court of Appeals for the Seventh Circuit.

In Equity.

No. 2459.

FRANK A. BONE, Plaintiff-Appellant,

vs.

COMMISSIONERS OF MARION COUNTY, Defendants-Appellees.

Stipulation.

It is hereby stipulated by and between the parties in the above entitled case through their counsel, that the certified transcript of the record filed in the Supreme Court of the United States in support of the Petition for a Writ of Certiorari herein, is the complete record

in this case, and that the same may be accepted by the Clerk of the Supreme Court of the United States and may be taken as a return to the Writ of Certiorari, dated March 11, 1918, and addressed to the Circuit Court of Appeals for the Seventh Circuit.

CLARENCE E. MEHLHOPE,
Counsel for Plaintiff.

Chicago, Illinois, March 19, 1918.

V. H. LOCKWOOD,
Counsel for Defendants.

Indianapolis, Indiana, March 23, 1918.

Endorsed: Filed Mar. 25, 1918. Edward M. Holloway, Clerk.

UNITED STATES OF AMERICA,
Seventh Circuit, ss:

In obedience to the command of the foregoing writ of certiorari and in pursuance of the stipulation of the parties, a full copy of which is hereto attached, I do hereby certify and return that the transcript of the record filed with the application to the Supreme Court of the United States for a writ of certiorari in the case of Frank A. Bone, appellant, vs. Commissioners of Marion County, appellees, is a full, true and complete transcript of the record upon which said cause was heard in the United States Circuit Court of Appeals for the Seventh Circuit, together with all proceedings in said Court.

In testimony whereof, I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this twenty-seventh day of March, A. D. 1918.

[United States Circuit Court of Appeals, Seventh Circuit.]

EDWARD M. HOLLOWAY,
Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

297 [Endorsed:] File No. 26352. Supreme Court U. S. October Term, 1917. Term No. 885. Frank A. Bone, plff. in error, vs. Commissioners of Marion County Writ of certiorari and return. Filed March 30, 1918.